EDISON ELECTRIC INSTITUTE BULLETIN

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EDISON ELECTRIC INSTITUTE

THE ELECTRIC LIGHT AND POWER INDUSTRY

Current Statistical Data Covering 100 Per Cent of Industry

April, 1941

SOURCE AND DISPOSAL OF ENERGY—MONTH OF APRIL

	1941	1940	%
GENERATION* (net)			
By Fuel Burning Plants	8,050,528,000	6,656,001,000	+21.0
By Water Power Plants	4,834,033,000	4,548,747,000	+ 6.3
Total Generation	**12,884,561,000**	**11,204,748,000**	**+15.0**
Add—Net Imports Over International Boundaries		72,556,000	.....
Less—Company Use	(Details	148,206,000	.....
Less—Energy Used by Producer	not yet	423,416,000	.....
Net Energy for Distribution	available)	**10,705,682,000**	.....
Losses and Unaccounted for		1,433,900,000	.....
Sales to Ultimate Customers	**10,809,394,000**	**9,271,782,000**	**+16.6**

CLASSIFICATION OF SALES

NUMBER OF CUSTOMERS—As of April 30th			
Residential or Domestic	25,185,950	24,237,301	+ 3.9
Rural (Distinct Rural Rates)	938,672	651,168	.....
Commercial or Industrial:			
Small Light and Power	4,257,602	4,205,417	+ 1.0
Large Light and Power	172,550	179,286	
Other Customers	117,356	113,701	.....
Total Ultimate Customers	**30,672,130**	**29,386,873**	**+ 4.4**
KILOWATTHOUR SALES—During Month of April			
Residential or Domestic	1,990,113,000	1,857,255,000	+ 7.2
Rural (Distinct Rural Rates)	130,760,000	126,196,000	+ 3.6
Commercial or Industrial:			
Small Light and Power	1,927,083,000	1,759,455,000	+ 9.5
Large Light and Power	5,821,360,000	4,607,756,000	+26.3
Street and Highway Lighting	159,882,000	154,711,000	+ 3.3
Other Public Authorities	241,045,000	220,788,000	+ 9.2
Railways and Railroads:			
Street and Interurban Railways	318,134,000	325,533,000	− 2.3
Electrified Steam Railroads	166,902,000	155,958,000	+ 7.0
Interdepartmental	54,115,000	64,130,000	−15.6
Total to Ultimate Customers	**10,809,394,000**	**9,271,782,000**	**+16.6**
Revenue from Ultimate Customers	**$210,078,400**	**$194,535,300**	**+ 8.0**

RESIDENTIAL OR DOMESTIC SERVICE (Revised Series)

AVERAGE CUSTOMER DATA—For the 12 Months Ended April 30th			
Kilowatthours per Customer	966	916	+ 5.5
Average Annual Bill	$36.71	$36.09	+ 1.7
Revenue per Kilowatthour	3.80¢	3.94¢	− 3.6

* By courtesy of the Federal Power Commission

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EDISON ELECTRIC INSTITUTE BULLETIN

Volume 9 JULY, 1941 No. 7

Forbes Prize Paper

Public Relations Cannot Be Improved By Magic

By Joseph R. Jarnagin

MY small son no longer believes that good fairies will substitute a coin for a recently extracted tooth placed under his pillow; the hanging of his stocking on the mantle at Christmas Eve has lost significance other than as a pleasant custom; he frankly admits that the idea of rabbits laying Easter eggs is silly. At the tender age of eight he has learned that material things do not come through magic.

Many older folks, too, have lost faith in the efficiency of mystic forces and discount the value of four-leaf clovers, old horse-shoes and wish-bones as a help in accomplishing great deeds or obtaining fame and fortune without personal effort.

But it seems at times as if otherwise sane and sensible utility executives have a tendency to keep on hoping and groping for some supernatural power or magical means of bringing about better public relations.

The private electric utility industry, and the vast majority of companies in it, have had too many socks on the jaw and have been forced to listen to too much hissing and cat-calls for even the most sanguine executive to fail to realize that the improvement of public relations is a highly important matter, but after several years of realizing this fact, and at a time when favorable public opinion is more necessary than ever before, many utility executives still appear preoccupied with dreams of discovering some mystic formula for converting public indifference into friendly interest; antipathy into cordiality; passive tolerance of political abuses against utility rights into determined individual and collective action against further abuses which might serve to handicap more efficient, more economical utility service.

MR. JARNAGIN

Mr. Jarnagin is the winner of the 1941 B. C. Forbes Prize.

Mr. Jarnagin joined the Carolina Power and Light Company in 1935 when the Sales Promotion and Advertising functions were merged under one department. He conceives and prepares for the Employee Relations Department its educational programs and the materials required in their administration. He is also responsible for the creation of all special promotions, and much of the company's public relations advertising.

During the first year of his connection with the Carolina Power and Light Company, Mr. Jarnagin planned a Revenue Recoverage program which won the National Public Utilities Advertising Association award. Previous to his association with the company, Mr. Jarnagin had wide and successful advertising agency and newspaper experience.

It is time, yes, time right now for utility executives to abandon faith in the prowess of wishing wells and good-luck talisman as a means of correcting public misunderstanding, indiffernce and antagonism. It is time for them to quit hoping and groping for supernatural aid and to adopt a definite systematic effort to create better understanding, sympathy and friendship on the part of the public.

Under present conditions which exist in most utilities, it is almost impossible for the most willing and capable executives to formulate a public relations program which can be carried out through the investment of money alone. While institutional advertising and similar gestures cannot be ignored as influencing factors, it is safe to say that improved public relations can be secured only as the result of a definite plan which includes the stimulation of a genuine spirit of cooperation on the part of each and every employee.

A great deal has been said about the value of employee relations in creating better public relations, and undoubtedly many utilities have spent considerable time, energy and money in creating employee relations programs, only to be disappointed in the failure of such activities to automatically produce improved public relations. Worthwhile employee relations cannot be secured by magic any more than public relations can be improved by mystical forces.

In planning an employee relations program, utility executives must face facts. Any successful program must be predicated upon an honest desire to actually benefit employees. The utility industry has grown very rapidly and the sheer rapidity of growth has caused many things to happen which would not have happened had the process of de-

velopment covered a longer span of time. Many operating utilities have grown to many times their original size within a brief period of years, and in the constant process of evolution the human element has gradually been dropped in favor of efficiency.

Let's trace the history of the utility business during the past decade or more and see what it is that has been lost in the process of evolution from the scattered, small companies of that period into the large organizations of today, with far-flung activities and centralized management—typified by the average electric utility company.

At one time, the business of generating and selling electricity differed little from any other localized business such as the making or selling of harness, flour and other commodities.

Then, electricity for homes, stores and factories came from small plants, often owned by individuals, whose management rested in the hands of the owner or manager, who was assisted by a handful of employees.

In those days, the utility head, like the butcher, baker and banker, knew practically every customer by name and was familiar with his or her habits and affairs. The relationship between company and customer was a highly personalized matter.

A blown fuse at Mrs. Green's home was a happening of personal concern to the utility head. He would stop on the street to explain to Mr. Brown why the lights flickered during last night's storm or to listen to Mr. White's complaint that the carbon bulb in his living room was burnt out. More than likely, it was the utility head who went to the customer's homes to correct troubles, and, if his call came at meal time, he remained to enjoy the customer's hospitality—and to cement the bonds of friendship!

Then, too, it was possible for the utility head to call each employee by his or her first name; to discuss freely the problems of the business with them, and, in turn, to listen to their problems, to reach for his wallet when Jim, the lineman, needed an extra twenty because Nell was about to have another baby or Jim, Jr., had broken his arm; to console Fred in an hour of bereavement and congratulate George when his daughter graduated; there were many such opportunities for close human relationship in those days!

And it was largely due to the close human relationship between the utility heads and customers and employees that the struggling companies, financially weak and inadequately equipped, were able to forge ahead—mutual patience, understanding and friendship offset service delinquencies—interest, loyalty, untiring willingness caused employees to render cooperation far beyond the bounds of duty—without these things, many of the earlier utilities could not have survived.

Then came the era of consolidation! One by one, the small companies merged and later became units in great systems. Occupied with technical, financial and organization matters of a complex nature, utility management became more remote in nature. No longer were utility heads privileged to keep in close contact with customers and employees. As marvelous gains in operating efficiency and service standards came, priceless human relations were involuntarily sacrificed!

In the rush and excitement of rapid expansion, the importance of the human equation was overlooked or, at least, given scant attention. The clasped hand ceased to be the symbol of relations between company and customer. The pat-on-the-back was no longer a token of employee recognition—in its place came the cold, clammy written memorandum. Customers lost status as individuals and became an inanimate group. Employees, as a whole, became cogs in the maze of organization machinery. Unconsciously, the human element was forgotten—and the loss has brought on severe penalties!

Many factors enter into the reason why the human element has again come to the fore to demand management's attention. Today, one of the imperative needs of the industry is re-established human relations on a straight-from-the-heart basis.

Obviously, the heads of a modern utility company cannot personally contact tens of thousands of customers nor can hundreds of employees, scattered over a wide territory, be extended the gratifying warmth of management's personal touch. This inability, however, does not lessen the acute need for the prompt regaining of the human element—what course of procedure can be followed?

As a substitute for the personal handshake and cheery word, which present day conditions render impossible for the utility management to extend on a scale commensurate with the needs, the pleasant task of humanizing relations should be delegated to each and every member of the organization—all along the line, from the highest executive down to the newest employee, every one should be made to feel his or her responsibility for regaining and maintaining genuine goodwill and friendship—each for the other and toward customers and general public.

Hence the need for a definite program, conceived in sincerity, properly planned, wisely administered, based upon an understanding of the value of the human element, that will awaken interest and desire among all employees to take an active personal part in making it more a pleasure for customers to deal with our organizations and for us to be members of them . . . a program that will restore every customer to his or her proper place as a human being instead of an entry on our account-file . . . a program that will cause every employee to feel that he or she has a more important and useful part in the company's work than merely to automatically perform routine tasks.

With the right type of sustained program, it should be possible to regain and to maintain the all-important human element!

What constitutes "the right type of sustained program"? The answer to this question depends, to a great extent, upon the individual utility's situation in respect to employee and public relations. Obviously, it would be impracticable to suggest a cut and dried program—indeed, such a procedure would bring us back to the realms of magic—however, definite suggestions can be offered upon which the rank and file of utility companies could formulate a practical program for their own use.

Objectives of the Program

Remembering that the prime purpose of the program is to inject more of the human element into the utility's relations with employees, customers and the general public, some of the specified objectives should be:

(a) To bring about a more complete and clearer understanding on the part of employees and customers of the company's essential part in the present day economic scheme of living and business.

(b) To create a greater realization of the company's contribution to the homes, farms, businesses and industries of the territory served.

(c) To create a greater realization of the company's untiring efforts to not only make the benefits of electricity available to as many people as possible, but to offer the highest quality of service at the lowest possible cost to the consumers.

(d) To create a clearer understanding of the company's fulfillment of it's obligations

to city, county, state and federal government and the value of it's financial contributions in the form of taxes in the support of all phases of public works that benefit the citizenship as a whole—such as, highways, schools, fire and police protection.

(e) To evaluate the important part taken by the company's employees in the business, social, civic and religious life of the many communities within the territory.

(f) To evaluate the worth of the company's efforts to improve the economic status of it's territory through the upbuilding of commerce and industry as well as agriculture.

(g) To, through the things just mentioned, create an understanding that the size (financial strength) of the utility is a factor in its ability to function efficiently; in other words, that

(1) The size of the company is an essential factor in enabling the masses to enjoy dependable electric service at low cost . . . just as the public understands that Ford's size and financial strength enables him to produce better cars at a lower price than could be expected from a small producer.

(2) The size of the company is purely a physical measurement without effect upon the human phase . . . that it is managed by men who are just as human as the corner druggist, the family doctor or other business men.

(3) The size of the company has no bearing upon its desire to be a good citizen of every community served nor is it a handicap to continuous efforts to promote the welfare of all with whom it comes in contact.

While, as previously intimated, a considerable amount of coordinated supplementary work is required to establish and maintain proper public relations, many of the basic objectives can be attained if due attention is given to proper employee relations.

With numerous employees, each with his or her own intimate circle of relatives and friends and with scores of acquaintances, the company has a means at hand of reaching and influencing a vast majority of its customers and a large portion of the entire population of its territory.

In the home circle, at the lodge, in church activities, as contacts are made with local merchants and casual acquaintances are greeted on the streets, countless opportunities arise for the company's personnel to do valuable "missionary" work. Money cannot buy the benefits that can be derived from the spoken words of the company's personnel provided these words are favorable and deal with FACTS.

Consequently, further objectives of the program should be:

(a) To stimulate employees' interest in the general affairs of the company.

(b) To create a clearer understanding of the company's policies and problems.

(c) To provide essential FACTS relative to the company's history, financial structure, operations as well as information about the functions of various departments and organization activities.

(d) To impress upon employees the value of interest, enthusiasm and loyalty in the upbuilding of the company and how that benefits the promotion of each individual's welfare.

(e) To assist employees in discovering ways and means of doing effective missionary work and in equipping themselves to discuss the company and its affairs intelligently.

(f) To create an environment favorable to increased appreciation of the company and an employee attitude that will assure the full and correct use of opportunities to exert favorable influence.

(g) To humanize to the fullest possible extent all employee-company relations—to promote closer coordination between individuals, between departments and between the scattered forces through the territory.

Such a program may be pronounced as idealistic by some because these objectives cannot be attained on short notice nor through a cut and dried plan or process. The program cannot be formulated by engineering technique nor can it be administered by an iron-clad set of rules and regulations. The molding of the thoughts and feelings of a large group of persons is an extremely difficult undertaking beset with many difficulties. Human behavior cannot be anticipated with any accuracy; consequently, the success of a program of this type rests in its flexibility in meeting the needs and moods of individuals.

In the setting up of an employee relations program due consideration should be given to the characteristics of the organization's personnel, individually and collectively, and every effort should be made by the management to ascertain absolutely true answers to the following pertinent questions:

(a) Are those comprising the personnel of one general type, with a common mode of thought and outlook, with the same living standards? If not, the program should be flexible enough to suit the intelligence of various groups.

(b) Are present working conditions of the rank and file of personnel satisfactory?

(c) Are individuals engaged in the type of work for which they are best fitted?

(d) Are employees adequately compensated?

(e) Are employees assured of proper promotion financially and otherwise?

(f) Are employees able to feel a sense of security?

(g) Are proper provisions being made for employees' education, such as letter writing, public speaking; also recreation and health preservation?

(h) Are suitable opportunities open to ambitious, energetic employees?

(i) Is sufficient interest being manifested in the away-from-business affairs of employees to assure freedom from lost efficiency due to family illnesses, unavoidable debt, domestic entanglements, and other causes?

The questions just listed touch directly upon things which most vitally affect the individual employee and regulate to a marked degree his or her attitude and behavior; consequently, these questions deserve the most careful analysis by the management before a definite program is adopted.

As will be noted, the human element is the paramount issue in each of these questions. It has been well proved in this day of social unrest that it is folly to treat employees as a mass, and any program set up for that purpose will, sooner or later, meet with failure. The only sound program is one flexible enough to meet the individual's needs and desires.

In securing factual answers to these questions and in analyzing the facts revealed, either of the following procedures can be adopted:

(a) The joint findings of the management and a committee of employees, who will frankly and freely consider each of the questions listed.

(b) The findings of competent investigators empowered to visit all sections of the territory and to interview all classes of employees.

(c) The management acting upon its own opinions as based upon statistics, reports, and similar sources.

A program of the type suggested cannot reach satisfactory heights of effectiveness unless the management is not only willing but determined to base its action upon a code of principles such as

(a) SINCERITY—an earnest desire on the part of the management to support a program of genuine value to employees.

(b) WILLINGNESS TO FACE FACTS—the elimination of prejudices or false illusions in favor of a program predicated on actual conditions and needs.

(c) A MEANS TO AN END—to inaugurate and maintain a program that will be of sufficient magnitude and duration to cover both short range and long range needs and objectives.

(d) TO HAVE A GOOD STORY TO TELL—to analyze conditions within organization and bring into execution such changes as may be necessary to form a sound foundation for employee benefits . . . which, in turn, will create employee loyalty, interest and enthusiasm.

Administration of the Program

The administration of a program of this type cannot be suggested without definite knowledge of each utility's size, operating policies and operating conditions. Obviously, the administration of a program in a metropolitan utility where the mass of employees are located within restricted areas would differ greatly from the conduct of such a program in a utility of the transmission type with employees scattered over a large area, and with its particular public com-

posed of various classes of population. In general, it can be suggested that a director of personnel work should head up the administration of the program under the direct supervision of high executives.

Much of the success of the program depends upon educational work and this educational process should start simultaneously with the induction of a new employee into the organization. A few hours spent in outlining the utility's functions, policies and purposes to a new employee will instill in his or her mind a worthwhile degree of interest, enthusiasm and personal responsibility.

Too often new employees are left to drift for themselves; to form their own opinions of the organization and to struggle single-handed in their search for facts.

Functions of the Program

To prove of value to the utility and its employees, an employee relations program should have certain specific functions, such as

(a) The supplying of easily understood, accurate information which will enable employees to discuss company affairs with the public in an intelligent, helpful manner.

(b) The educating of employees along lines that will increase their usefulness to the company and so promote their own well being.

(c) Through a clearer understanding serve to better coordinate relations between various departments of the company and the individual employees.

(d) To bring to employees' attention vital information pertaining to the electrical industry and data of personal value to them along lines of self-betterment that might not otherwise be available to them.

(e) To pass on responsibility for employee-customer relations of the proper type to Department Heads, Plant Superintendents, Foremen and others in supervisory positions and to equip them to better instruct those under their direct supervision . . . to see that informative materials are received, understood and applied in an effective manner.

In order that these desired functions may materialize, certain specific suggestions for an employee relations program should be mentioned for consideration. Obviously, it is illogical to attempt to offer a complete list of suggestions, however, there are certain specific suggestions which can be outlined with the full realization that many utilities are already carrying out similar activities in all or part.

(a) That a systematic method of hiring new employees be established. Many concerns find a personnel director indispensable while others depend upon a personnel questionnaire which must be passed on by the personnel department before an application for employment is finally acted upon—this largely eliminates misfits, assures assignment to congenial work and provides information of value in evaluating the employee's probable and actual worth to the company.

(b) In a utility company there are certain to be many employees who are engaged in uncongenial work or assigned duties which they are not properly handling, consequently, a job analysis should be made of the entire personnel below the rank of department heads. The importance of a comprehensive job analysis cannot be overestimated as it will lead to reassignments and other changes promoting departmental efficiency and will provide means of evaluating the worth of present employees.

(c) A practical method of setting up a promotion standard should be devised. Employees, who face increasing personal responsibilities and advancing age, grow restless in the face of absolute uncertainty as to chance of advancement.

(d) Likewise employees grow restless and discontented when services that are apparently satisfactory are not rewarded by compensation increases, therefore, a standardized system of compensation increases is desirable. A system of moderate increases would tend to quickly eliminate those who hope for advancement through favoritism and would stabilize the personnel as a whole.

(e) A definite code governing dismissals would tend to dispel uncertainty to a large extent.

(f) A form of an old-age retirement plan, based on employee-company participation, would eliminate the lack of a sense of security for those desiring to make their present work a lifetime career.

(g) A systematic method of providing employees with means of health examinations, with provisions for correction of minor ailments or conditions in preliminary stages, at moderate cost would largely curtail serious illnesses.

(h) A definite, clearly understood company policy regarding payment of salaries during illnesses should be created.

(i) A regular supply of accurate, timely information about the company's activities and problems should be made available to employees through a semi-monthly bulletin. Information of interest to the public which could be passed on by employees should be written up in a brief, easily understood style.

(j) Additional information of a more comprehensive nature should be supplied department heads, district managers and others in authority for their use and for passing on to key employees.

(k) News and information pertaining to the industry should likewise be made available to the personnel.

(l) Company house organs should be used with emphasis placed on personnel news, pictures and other materials of a system-wide interest.

(m) Courses in letter writing, public speaking, business English, as well as specialized courses in other subjects, should be made available at nominal cost for the benefit of employees wishing to improve themselves.

(n) Sales Training should be supplemented by a systematic disbursement of information of value to sales representatives in contacting the public.

(o) Sports and recreation should be encouraged with provisions made for an investment in equipment and supplies. In localities where the company has available suitable property, inexpensive recreation facilities should be provided, also, equipment for outdoor cooking for employees' use.

(p) Greater emphasis should be placed on the company's insurance program which is, at present, taken as a matter of course.

(q) The Safety Department's work should, also, be given more prominence.

(r) Department heads and others in a supervisory capacity should be encouraged in checking the efficiency, attitude and general conduct of employees and in reporting cases of meritorious effort.

(s) Those in charge of employees' relations should be given wide latitude in dealing with the problems of individuals. Many factors regulate an employee's efficiency and means should be provided for the personnel relations administrators to render a wide range of useful service to employees . . . a firm but sympathetic handling of problems would bring mutual benefits to employees and company.

(t) A greater spirit of friendliness, not necessarily intimacy, should be encouraged between supervisory forces and those under their supervision with a view of creating a larger sense of individual interest and responsibility.

(u) Encouragement should be given individuals to take part in civic affairs in their respective communities, and to participate in social, fraternal and church affairs thus to open the way for more contacts of personal and company value.

(v) Such organizations as company social clubs should be encouraged, especially in the larger centers, with proper emphasis on the necessity of keeping such organizations as strictly employee projects, free from domination by company officials.

(w) An occasional tour through the territory of a small group of selected company employees to stage interesting and amusing skits would stimulate employee interest and would serve to bring the remotely located personnel in closer contact with the home office. In a similar way, instructive lectures and movies could be advantageously employed.

(x) Higher executives of the company could profitably take more recognition of local events throughout the territory and be present or represented on occasions of genuine importance.

(y) Anniversaries of employees, terms of service, birthdays, weddings, and other events could well be noted by a telegram or letter.

(z) Administrators of the employee program should be empowered to maintain intimate contact with employees throughout the territory and to inaugurate such local activities as might prove beneficial in the instruction of employees or cultivation of closer relations.

(aa) Closer attention should be given to visits during illness or bereavements, with the administrators of employee relations given authority to use discretion in promoting employees' comfort during such circumstances.

(bb) Employee administrators should be available to the rank and file of employees for the discussion of minor legal problems, with services of the legal department available for advice through personnel administrators, opportunities for self-betterment, domestic relations and other matters which vitally affect employees' attitude and efficiency.

(cc) A suggestion box, in which employees might place suggestions of various kinds,

(*Continued on page* 327)

Partnership Between Manufacturers and the Power Industry Is Vital Now

By D. C. Prince

Manager, Commercial Engineering Department,
General Electric Co., Schenectady, N. Y.

Address before the Fourth General Session of the Ninth Annual Convention of the Edison Electric Institute, Buffalo, N. Y., June 5, 1941

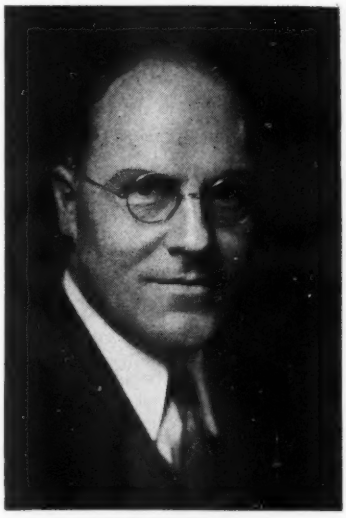
"BETWIXT the Lakes of Ontario and Erie there is a vast and prodigious Cadence of Water which falls down after a surprising and astonishing manner, so much so that the universe does not afford its parallel." Thus wrote Father Hennepin in December, 1678. Peter Kalm, a botanist from Sweden, writing to his friend, John Bartram in Philadelphia, in September, 1750, as one scientist to another, was critical of the good Priest's ability to observe accurately.

"Father Hennepin supposes it 600 Feet perpendicular; but he has gained little credit in Canada; the name of honour they give him there, is un grand Menteur, or the Great Liar; he writes of what he saw in places where he never was. 'Tis true he saw this Fall: but as it is the way of some travellers to magnify every thing, so has he done with regard to the fall of Niagara. This humour of travellers, has occasioned me many disappointments in my travels, having seldom been so happy as to find the wonderful things that had been related by others. For my part, who am not fond of the Marvellous, I like to see things just as they are, and so to relate them. Since Father Hennepin's time, this Fall by all accounts that have been given of it, has grown less and less; and those who have measur'd it with mathematical instruments find the perpendicular fall of the water to be exactly 137 feet."

Even to the unemotional eyes of the Scientist, Niagara was quite a waterfall. But it was not apparent to the men of that time what services this great cataract would render.

History of Niagara Power Development

The falls were viewed at first mainly as an obstacle to navigation. Flour and cotton goods to the interior had to be portaged around them. Chabert Joncaire, a Master of the Portage, was the first we know who thought of Niagara also as a source of power. In 1748 he dug a ditch 6 feet wide and 4 feet deep, diverting some of the water from the rapids above the fall to run an overshot wheel for a saw mill. Later John Stedman had a saw mill on the same site; but the canal had filled with silt when



MR. PRINCE

Augustus Porter at a New York State Public Auction bought the lands adjacent to the falls. He had been on his way West but, attracted by the falls, stopped there. He built a grist mill on the site of the two saw mills. Still the great Niagara drove just one mill. In 1825 the Porters issued an invitation to capitalists to help them develop the river, but there were no takers.

The first company to attempt a power development was formed in 1853. It raised and spent $500,000 and went broke having produced no power. A second company had completed a canal by 1860 and failed with still no power. A third company carried on, supplying one grist mill. This company was sold under the hammer in 1877 for $71,000 to Jacob Schoellkopf. By 1882 Jacob Schoellkopf and his associates had built a small power house driving seven mills and a Brush dynamo operating 16 arc lights.

From the time of Father Hennepin's visit it took just over 200 years to achieve a substantial beginning in employing the possibilities of the Falls.

Growth in the use of the power was slow, and it was not until 1920 that the Federal Water Power Commission was formed to license the use of water, signifying full utilization.

The triumph of the pioneering vision that was finally successful in harnessing the potential energy of Niagara has helped to make the Buffalo area one of the principal manufacturing centers of the United States. The following figures taken from the U. S. Census of Manufactures illustrate the industrial development of the Buffalo area:

In 1937 the manufacturing output of this area amounted to about a billion dollars. This is approximately the value of manufactures for the whole United States in 1853. The value of products per worker in the Buffalo area in 1937 was about 9 times greater than for the whole U. S. in 1853. Corrected for the change in the price level between 1853 and 1937, the volume of output per worker in the Buffalo area in 1937 was 6 times greater than the volume of output per worker in the U. S. in 1853. These figures give a rough measure of the industrial progress that has been realized by harnessing the power of Niagara.

Relation of Power Development to National Income

This is an example of the reasons why Americans have come to measure civilization and the standard of living in terms of the amount of power available per man. This very achievement, to some extent, may have dulled our sense of perspective. Perhaps we have grown cautious and reverted to the skepticism which failed to see the blessing of power while three development companies went to ruin, forgetting that the present success sprang from those beginnings. When we oppose some power developments, we are accused of having forsaken our own god.

Perhaps there is something in this

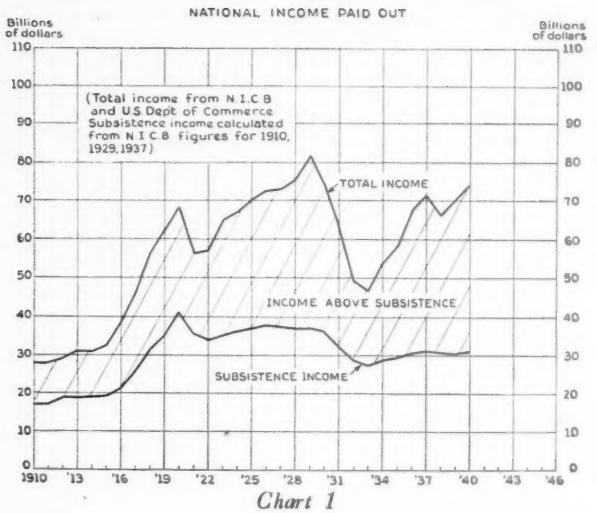
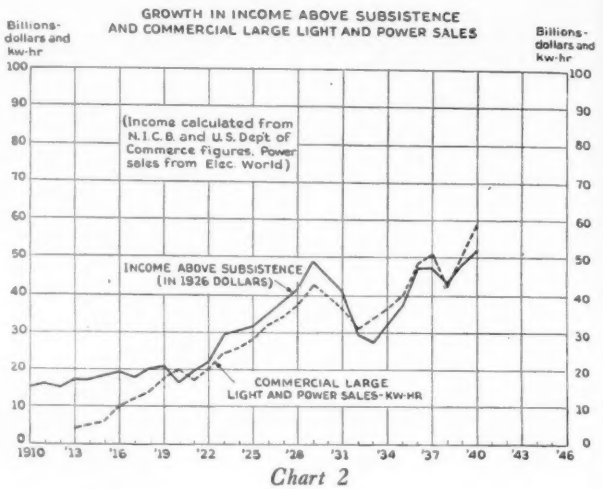

NATIONAL INCOME PAID OUT
Billions of dollars
Billions of dollars
(Total income from N.I.C.B. and U.S. Dept of Commerce Subsistence income calculated from N.I.C.B. figures for 1910, 1929, 1937)
TOTAL INCOME
INCOME ABOVE SUBSISTENCE
SUBSISTENCE INCOME
1910 '13 '16 '19 '22 '25 '28 '31 '34 '37 '40 '43 '46

Chart 1


GROWTH IN INCOME ABOVE SUBSISTENCE AND COMMERCIAL LARGE LIGHT AND POWER SALES
Billions-dollars and kw-hr
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(Income calculated from N.I.C.B. and U.S. Dept of Commerce figures. Power sales from Elec. World)
INCOME ABOVE SUBSISTENCE (IN 1926 DOLLARS)
COMMERCIAL LARGE LIGHT AND POWER SALES-KW-HR
1910 '13 '16 '19 '22 '25 '28 '31 '34 '37 '40 '43 '46

Chart 2

view. Let us re-examine some of the basic relationships between the growth in our purchasing power and the growth in the use of electric power. With these relationships, let us make a rough blueprint of the next few years, estimating the probable effect of the Defense Program on our economy and the possibilities of renewing the growth in our standard of living after the war.

Before the coming of power, men had to spend almost their entire time keeping body and soul together. Whether they were slave or free, a negligible proportion enjoyed more than enough income for bare subsistence.

By 1910 the use of electric power began to be an item in major industry. The total horsepower in industry in 1910 amounted to 18,600,000—but only 24 per cent of this was electric. As the use of power rose, our surplus over bare subsistence rose too. By 1939, horsepower in manufacturing industry rose to 51,200,000 and by then about 86 per cent was electric.

Chart 1 gives the history of National Income from 1910 to 1940 showing in addition that portion required to maintain bare subsistence.

In Chart 2 we see that since 1920 our margin over bare subsistence in 1926 dollars has been almost directly proportional to our use of electric power in industry. With the aid of Niagara the productivity per man in the Buffalo area has been multiplied by six. With the aid of electric power the National Income above a bare subsistence has been multiplied by three from 1920 to 1940, at the same time that the use of large electric power has also been multiplied by three. We in the electrical industry do not believe this is merely a coincidence.

Since the last World War we have increased the use of electric power to help expand our margin of income above subsistence. Now we find it necessary to increase the use of electric power to provide for National Defense.

Division of 1940 National Income

So let us examine in some detail the division of National Income and Output in 1940. This will enable us to see how much we have required for expenditures other than Defense, and will give us a basis for estimating how increasing Defense expenditures may affect our economy.

In Chart 3 the left-hand bar shows the gross National Income of the country in 1940. It amounted to 82.2 billions of dollars. To earn it, 47 million people worked an average of 40 hours per week. Of that $82.2 billions, $63.5 was for all consumer expenditures—food, housing, clothes, automobiles, etc.; $1.8 was paid out for personal taxes; and $9.0 was saved by individuals. The total of these items is $74.3 billions or the amount of national income paid out. In addition, there were business savings and depreciation reserves amounting to $6.0 billions, and $1.9 billions representing miscellaneous items which cannot be definitely identified.

Now let's see how this gross National Income was spent. $30.9 billions were required for bare subsistence of our 130 million people (food, clothes, housing, etc.), $32.6 billions represent expenditures above subsistence for such items plus $8.3 billions for consumer durable goods, such as automobiles, refrigerators, etc.

To produce these things we replaced plant and equipment and, also, expanded these facilities. We also built public works, houses, stores, etc.; $14.7 billions were spent for such items. These expenditures, plus inventory accumulation, we have called capital formation.

Effect of Defense Program on National Income

The remaining expenditures of $4.0 billions in 1940 went for National Defense ($2.7) and for the excess of goods and service exchanges with foreign countries (largely accounted for by war materials exported to the British Empire).

Although 1940 was a year of active preparation, Defense expenditures did not cause any marked dislocation of our economic structure. We had a National Output of $82.2 billions, of which only about $2.7 billions were spent directly on National Defense. We will probably spend more than that each year for many years after the present war, no matter how it comes out.

Now in 1941 we are engaged in an all-out Defense effort. It is difficult to obtain a perspective of our ordinary and long-range social and economic picture amid barrages of propaganda. In spite of these difficulties, the effort must be made. Many people consider the "Roaring 20's" and the Crash that came after as associated with World War I. Without arguing the extent of that association, it is probable that a marked decrease in business activity will follow this war—whether or not we are directly involved—*unless* we are able to plan a program now that will enable us to replace the Defense effort with productive peacetime activity.

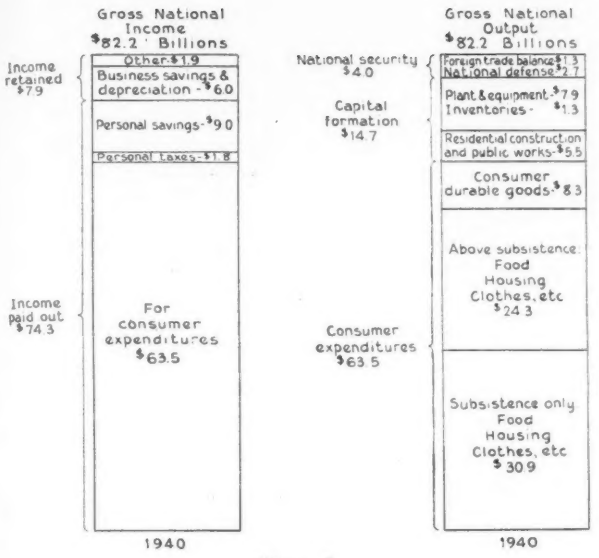


Chart 3

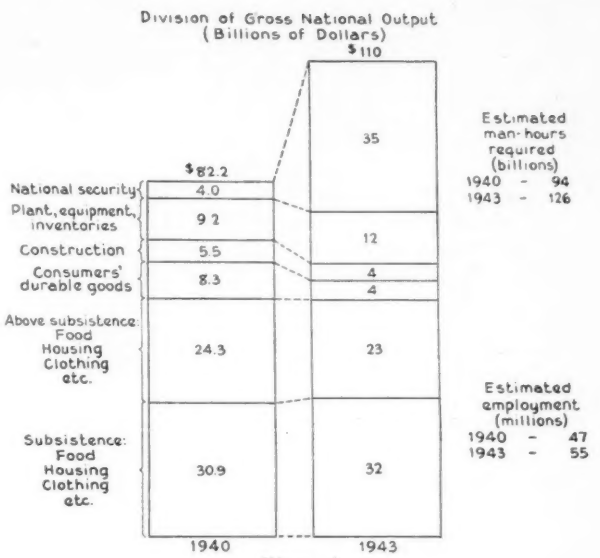


Chart 4

We are fortunate, in a way, in having the two catastrophies within a single business lifetime. Many of us have had an intimate enough contact with the former period so that we should be able to avoid falling into the same traps a second time. Analysis of the immediate past should indicate future steps by which we may determine whether we will move toward communism, totalitarianism, socialism, or a freer democracy.

The figures which I present in this analysis offer endless opportunity for discussion in detail, but it is on the broad picture that I ask you to focus your attention this morning. Incidentally, all estimates are on the basis of the 1940 price level.

We are now definitely caught in the Defense maelstrom so that we may well be curious where it is leading us, and what departures from the relatively normal 1940 are in prospect. We have made the following three assumptions on the effect of the defense program: (1) that defense plus aid to Britain will be expanded to $35 billions by 1943, (2) that reemployment of 8 million men and expansion of power use by 30-35 billion kilowatthours between 1940-43 will mean that a very large part of the Defense Program in 1943 will be provided for by expansion of total national output, (3) that curtailment of peacetime industry will be largely confined to construction and consumer durable goods.

The distribution of productive output for 1943 assumes a 34 per cent increase in total national output between 1940 and 1943 in terms of 1940 prices. If, because of national emergency, the defense program is greater than 35 billions in 1943, or if bottlenecks of production prevent us from expanding total output as much as we have assumed, the billions available for consumer expenditures will be considerably below the $59 billions we have allotted for this item in 1943.

Now let us look at the second bar of Chart 4, which is an estimate of where we may expect to be by 1943 if our original assumptions hold. We shall have a total National Output of $110 billions which will flow from the work of 55 millions of people working 46 hours per week. That is assumed to be full employment of all employables on an overtime basis. The segment of defense effort is expanded to 35 billion dollars. Business capital formation is increased from $9.2 billions to $12.0 billions to support the Defense effort. Residential construction and public works are decreased from $5.5 to $4.0 billions. Spending for consumer durable goods has contracted 50 per cent because of the unavailability of men and materials to make these products.

Post Defense National Income

At some future time—we hope it can be 1946—the war will have terminated. If it should terminate in a German victory, the 1943 chart will serve well enough for 1946. We are committed to prevent that outcome if we are able, and since we have a way of succeeding in what we set out to do, we should at least consider the other alternative, that Hitler will have been defeated and that by 1946 we are again free to build our lives in accordance with our own designs.

There are many reasons why we should prepare such designs. The general scheme of fifth column activity is directed toward fomenting disunity. If we have a design on which we would like to construct our lives, that is an element of unity. The defeatists say that the democratic process is hopelessly inefficient, and that private industry takes no thought of the people of whom it is made up. If we create and carry out a plan whereby Government and business can cooperate in democratic free enterprise for the interests of the whole people, we can prove the value of free enterprise. Therefore, we must have a plan and carry it out.

Of our 35 million families in 1940, 11 million had incomes of less than $1,000 a year, a bare subsistence income. As a first step, suppose these families were provided with work so that they could raise themselves to a $1,500 level —a level at which they could have some of the things required for just a modest standard of living, including automobiles, washing machines and refrigerators.

Besides the 11 million families in the less-than-$1,000 per year class, there were seven million more with incomes between $1,000 and $1,500. To raise the average of these 18 million families to the $1,500 level will require 10 billions of dollars.

By 1946 it will require some $3 billion more than in 1940 to supply food, clothes, housing, etc., for a larger popu-

lation. Also, since we do not wish to freeze the incomes of all above $1,500 we will allow this group about $5 billions. We will need to spend about $4 billions more for plant and equipment than in 1940, to support these contemplated increases in consumer outlay, and for national security which may require some $6 billion more than in 1940. It seems likely that we shall have to maintain a two-ocean navy and an expanding army and air force for some years. Also, some capital will be needed to support the development of peacetime foreign trade.

In summary, we note that by 1946 our National Output should be $28 billions greater than in 1940 to do these things. (See Chart 5.)

	Increases (in billions) 1936 over 1940
Raise average of 18 million families to $1,500	$10
Provide for increase in population	3
For families above $1,500	5
National Security	6
Plant & Equipment Expenditures	4
Total	$28

The third bar of Chart 6 shows the effects of these increases on the various divisions of our total National Output. To produce this total of $110 billions in 1946 will require continuing full employment (57,000,000 people) for 43 hours a week. This means 123 billion man-hours compared with about 94 billions for 1940.

It will be apparent from these figures that if we wish to maintain the National Output, all of us must keep working to do it—and working 43 hours per week.

This bar chart may be analyzed in a number of ways. The work week may be divided up to show the composite man works 13 hours to keep his family and himself alive. Then he works 17 hours to make that life worth living. After that he will work four hours to see that no Hitler may again terrorize hundreds of millions of people like himself. The last nine hours he works for maintenance and expansion of the plant, equipment, construction, etc., so that a continued expansion in the standard of living is possible.

Another way of looking at it is that if we go back to 10 million people unemployed, or if we distribute that amount of work, all sharing alike but working only 35 hours per

	Increase 1946 over 1940 (Billions)
To raise average of 18 million families to $1500	$10
To provide for increase in population	3
For families above $1500	5
For National security	6
For plant and equipment	4
Total	$28

Chart 5

week, we shall have reduced our National Output to $90 billions ($8 billions above 1940 used up by increase in population and by national security expense increase). The $20 billions lost will nearly wipe out our growth factor, our ability to improve our living standards; or we shall force back to a share subsistence income, or below, all the 11 million families we raised from that level, and many more besides.

We do not view this situation with alarm. The fifth column forces cannot make us view with alarm. Rather let us analyze what possibilities a 110 billion dollar output, produced by 57 million people working 43 hours a week, present to the electrical industry, the partnership of power producers and electrical manufacturers. Ten billions of dollars' worth of products will be produced to raise 18 million families to the $1,500 level. Many of these families will then, for the first time, be in the market for electric appliances and other types of durable consumers' goods. In fact, sales of such products to these and other families may be $5 billions, or 50 per cent greater than in 1940. The $10 billions will provide new and better homes—more homes to be wired for electric ranges and air conditioning. All of these things will cause a large increase in the domestic load. Of course the industrial load for peacetime production must increase also. Someone must make these extra refrigerators, washing machines, and automobiles. These people must be transferred from the ranks of the munitions makers. The building material processors and makers of appliances will use some of the power released by the munitions makers.

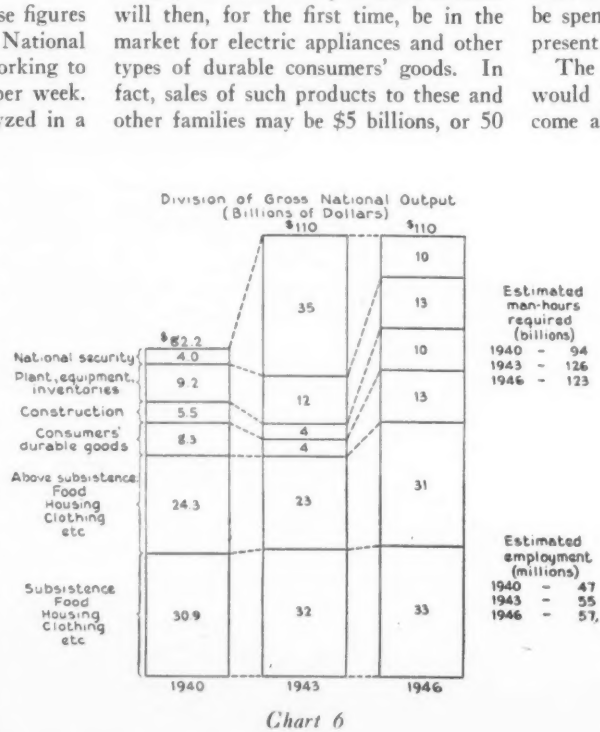


Chart 6

We have seen that as the income above subsistence increases, the industrial power load rises also. Let us now see how much power would be required (on the basis of past relationships) to produce the income above subsistence that would be produced in 1943 and 1946, with a National Output of $110 billions. Chart 7.

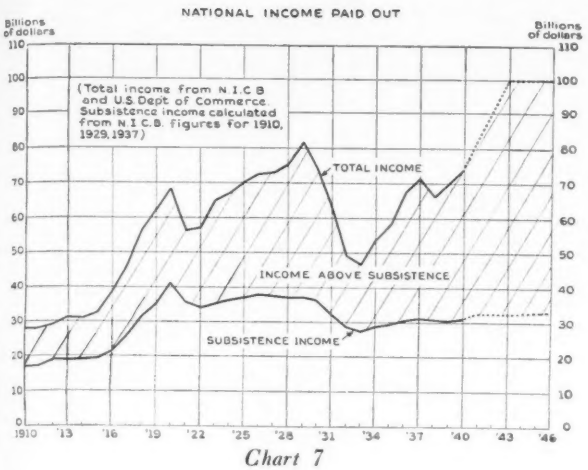
ESTIMATE OF INCOME ABOVE SUBSISTENCE AND INDUSTRIAL POWER LOAD IN 1943 & 1946

	Nat'l Income Paid Out	*Subsistence*	*Above Subsistence In '26 Actual*	*Above Subsistence In '26 $*	*Power Loads (Billions Kw-hrs)*
1940	74.3	30.9	43.4	52.4	59.5
1943	100.0	32.0	68.0	82.0	80.0
1946	100.0	33.0	67.0	80.6	85.0

In 1943 the ratio of the power load to income above subsistence is expected to be less than in peacetime years, largely because by 1943 a smaller percentage of total defense expenditures will probably be spent for output of industry than at present.

The National Income Paid Out would be about $100 billions, and income above subsistence would be about $68 billions in 1943 and $67 billions in 1946. In 1926 dollars these figures become 82 billions and 81 billions. Chart 8. At these levels of income above subsistence, commercial large light and power sales would total 85 billion kilowatthours in 1946. If our total output were only $90 billions in 1946 (comparable with the $82 billions in 1940 after allowing for population growth and for increased defense outlays) then the commercial load would probably drop to around 65 billion kilowatthours. This indicates how important it is to the electrical industry to maintain our gross national output at 1943 levels.

Finally, let us turn back to our chart or blue print of Na-


NATIONAL INCOME PAID OUT
Billions of dollars
Billions of dollars
(Total income from N.I.C.B. and U.S. Dept of Commerce. Subsistence income calculated from N.I.C.B. figures for 1910, 1929, 1937)
TOTAL INCOME
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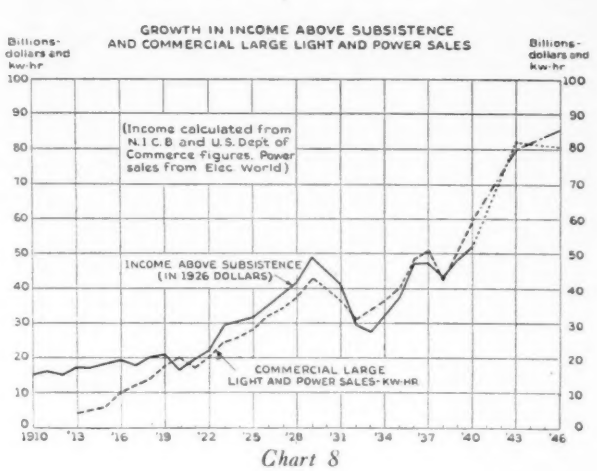
SUBSISTENCE INCOME
1910 '13 '16 '19 '22 '25 '28 '31 '34 '37 '40 '43 '46

Chart 7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COMMERCIAL LARGE LIGHT AND POWER SALES-KW-HR
1910 '13 '16 '19 '22 '25 '28 '31 '34 '37 '40 '43 '46

Chart 8

tional Output for 1946. Chart 6. As just indicated, if we can maintain this output at $110 billions, we will be making use of all the power and productive facilities available. The question is how to bring about this transition from war to peace without a major let-down.

So far we have shown that United States production rests on electric power. We have shown how that production was divided in 1940. We have estimated how it will be divided when the Defense program is in full swing in 1943. That production should amount to 110 billions of dollars.

If the nation can produce 110 billion dollars' worth of products for war, it can do it for peace; but it will have to work almost as many hours to do it. Considering the number of our population who have not yet enough food or proper homes, to say nothing of radios and automobiles, we believe our people will prefer to work for 110 billions than loaf for a lesser income. In the case of peace products the distribution of productive effort will be different from that for war. A reasonable peacetime distribution of such effort has been indicated. Besides being reasonable from a production standpoint, it must be reasonable from a purchasing power standpoint. There must be people with purchasing power to buy the products. The three categories—subsistence, above subsistence and consumer durable goods—add up to 77 billions, or 13.5 billions more than the 63.5 billions in these categories in 1940. In 1940, 67 per cent of the National Income Paid Out was in the form of wages, salaries, relief, and social security payments. Applying this same percentage to the estimated national income paid out for 1946, the total wages, salaries, social security, etc., would add up to 67 billions, or 17 billions more than in 1940.

The wage earners' increase in purchasing power is more than enough to buy the added production of consumer goods suggested. The wage earner can be depended upon to spend his wages; he always has, even before the policy was adopted of caring for the profligate as well as the unfortunate at some minimum level. The detailed makeup of the 77 billions that will be spent by individual consumers is closely predictable. Department of Labor and other statistics show the distribution of expenditures at every income level. As each family income is increased, its expenditure pattern conforms to the group into which it moves. Our store buyers know how to add the figures up to determine how many washers and vacuum cleaners are involved.

The allowance of 10 billions for construction contemplates 6 billions for the erection of 1.5 million homes in 1946. 325,000 are needed for replacements and new families; 500,000 to make up for war time deficiencies; and 675,000 to replace dwellings unfit for occupancy. This compares to a previous high of 900,000 in 1925, but even at 1.5 million it would take nearly 25 years to house our whole population. A low rate of construction for many years has created a housing demand which cannot be quickly filled. This building program may require stimulation by large scale housing corporations similar to those developed in England after the World War. These will not require government subsidy because with full employment our people can pay their own way and will prefer to do so.

Based on data for the past years, public construction of superhighways, water supplies, sewerage facilities, public buildings, etc., should require about ¼ billion dollars to satisfy our needs.

It is anybody's guess whether $10 billion will meet our defense and foreign trade needs in 1946; but the amount will be gladly spent annually for years if it insures a world at peace. In a sense, the plant and equipment item represents the capital investment required to make the economy operate and expand. From it the wear and tear must be made good. But much of the deterioration will be in obsolete armament plants while the new investment will be by the provident in converting a wartime to a peacetime production. That expenditure is in our hands.

Our partnership of power and manufacture will not have to create the 1946 economy out of whole cloth; but by planning the expenditure of the $13 billions for plant equipment and inventories, which represents growth, we will be able to regulate the system so that it runs steadily. Classical economists supposed that such things were automatically taken care of by the laws of supply and demand. We know to our sorrow that either by nature or due to human interference our machine age is unstable and does not regulate itself. The problem is to decide as between Government and Business who will do the regulating.

Let us make a plan showing how we think the transition from a wartime to a peacetime economy should be made. The plan should contemplate progressively higher standards of living brought about by greater power consumption. If it is a good plan, we should be able to sell it; but we will have to start soon if we expect to have our plan ready in time.

Performance of Distribution Capacitors

By M. C. Miller

Electrical Engineer, Ebasco Services Incorporated

A Paper Presented at a Meeting of the Transmission and Distribution Committee, E. E. I., Chicago, Ill., May, 1941

THE purpose of this paper is to present an up-to-date summary of performance of capacitors installed by electric utilities. It covers performance of 139,400 kva of capacitors, these units mostly of the pole-type, developed in 1937. This summary supplements performance data presented at the May, 1939, meeting of the Transmission and Distribution Committee.

While capacitors were installed by utilities prior to the development of the pole-type units, these smaller more easily installed units have given a real impetus to widespread use of capacitors on distribution systems.

Data received from 15 companies are included in Table I. These data indicate a failure rate for the year 1940 of only-six-tenths of 1 per cent (0.6%) of the total installed at the end of 1940.

Failure of 20 units (two-tenths of 1 per cent) of total installed, was due to defective materials, workmanship or design. This includes failure of seven gas-filled units.

Failure of 17 units, less than two-tenths of 1 per cent of total installed (0.2%), was attributed to lightning. Nine of these 17 units were on one system having a total of 15,460 kva of capacitors. For that one system, the failures from lightning were nine-tenths of 1 per cent (0.9%).

Failure of 4 units were attributed to switching surges, high voltage or mechanical damage.

The cause of failure of 13 units was reported as unknown.

This is a highly satisfactory performance record.

This performance record probably is fairly representative of the country as a whole, as data are included from various parts of the country—New Jersey, Louisiana, Texas, Oklahoma, Idaho, Nebraska, Missouri, etc.

There is some question as to the economy of providing lightning protection for capacitors when connected between phase wire and solidly grounded neutral. A number of companies reported that wye connected capacitor installations are made without lightning protection. Others, and probably the majority, install protection for each bank. Co No. 3, (see Table I) with 15,460 kva of capacitors installed on a wye system, reported that arresters are installed on 75 per cent of the banks and omitted on 25 per cent. Of nine failures during 1940 attributed to lightning, four were in banks with arresters and five in banks without arresters.

Co No. 5, with 8865 kva installed on a wye system, reported 16 banks with arresters and 87 banks without arresters, and that one unit failed in 1940 from lightning. It was in a bank without arresters.

Co No. 6, with 1395 kva installed on a wye system, reported that no lightning protection is provided on any bank and no failures occurred in 1940, although distribution transformer failures and fuses blown from lightning during 1940 were unusually high compared to previous years.

More complete data on percentage of failures from lightning, as related to use of or omission of lightning protective equipment, and segregated by relative capacity of banks, would be helpful in deciding whether the cost of protective equipment will provide a sufficient reduction in failures from lightning to justify the added investment.

Benefits from Capacitors

Numerous articles have been published, and papers presented to show the many benefits which may be derived from capacitor applications; therefore, benefits of the usual nature have not been included in this paper. While those articles and papers mentioned that benefits would be obtained on transmission lines and substations and kva loading on generators would be reduced, it appears that such benefits have not been investigated sufficiently for evaluations. Applications have been made principally

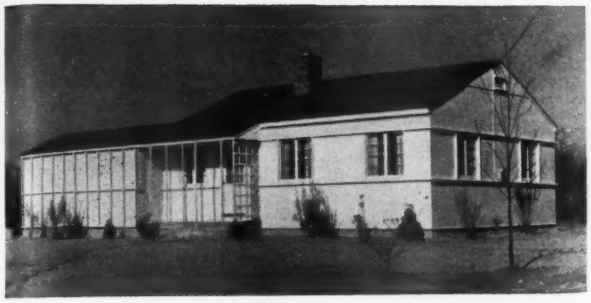
(*Continued on page* 328)

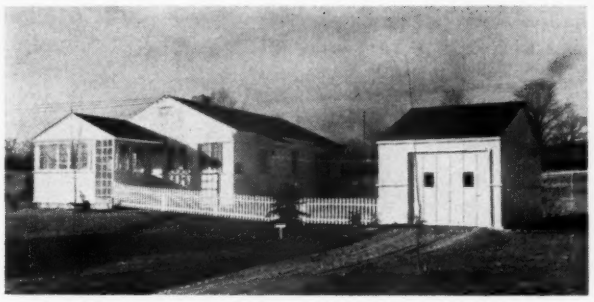
TABLE I—TABULATION OF CAPACITOR PERFORMANCE DATA FOR 1940

Kva of Capacitors Installed—Number and Cause of Failures

	Kva Installed			Failures During 1940 — Number of Units								
Co No. (1)	Prior to 1940	During 1940	Total	Appx. No. of Units	Defective	Lightning	Switching Surges	High Voltage	Harmonic Loading	Mechanical Damage	Unknown	Total
1	3,555	810	4,365	291		1						1
2	1,665	600	2,265	151		3					2	5
3	15,460		15,460	1,041	1	9					2	12
4	2,565	1,410	3,975	265	1							1
5	8,865	0	8,865	591		1						1
6	540	855	1,395	93								0
7	1,170	0	1,170	78							2	2
9	930	0	930	62								0
10		2,565	2,565	171								0
11	720	30	750	51		1						1
12	2,250	90	2,340	156								0
14	19,665	6,720	26,385	(2)1,627	7(3.)		2	1				10(3)
15	10,983	3,945	14,928	1,000								0
17	19,848	— 105	19,743	(4)1,350		2				1	3	6
18		(5)	34,245	2,283	11						4	15
Total	88,216	16,920	139,381	9,210	20	17	2	1	0	1	13	54
												0.6%

NOTES:
(1) Company numbers shown correspond to those included in a paper "Performance of Distribution Capacitors" included as Appendix IX to Minutes of the Nineteenth Meeting, Transmission and Distribution Committee, EEI, Chicago, Ill., May, 1939.
(2) Includes approximately 20 — 120 kva gas filled capacitor units.
(3) Includes failure of 7 — 120 kva gas filled capacitor units.
(4) Includes 4,288 kva of customer owned or leased capacitors.
(5) Years in which capacitors were installed were not reported.





Typical Low Cost Electrified Homes Erected by John B. Pierce Foundation.

The Low Cost Electrified Home

By Henry J. Morton

Sales Promotion Manager, Pierce Laboratory, Inc.

Address before the Third General Session of the Ninth Annual Convention of the Edison Electric Institute, Buffalo, N. Y., June 4, 1941

WHAT does the future hold for the Electric Light and Power Industry?

True—there are many dark clouds on the horizon. Many immediate obstacles may seem insurmountable and require the bulk of executive attention. For that reason it might be in order to inject a brief commentary of a more optimistic nature.

It is evident from the business discussions among you that load building plans subsequent to the expiration of the present debacle are receiving serious study. Many of you have personally expressed hope that domestic and small commercial users can be persuaded to take up most of the "slump" which will ultimately result.

Economic possibilities of a larger percentage of home ownership has been receiving considerable attention for many months by both industrial and governmental personnel. An active home building industry may be a valuable contribution to offsetting the reaction and the aftermath of what is now happening.

"Pre-fabrication" is a popular word among industrialists. As applied to the construction of homes for families, it deserves your attention and consideration.

Assuming that mass provision of individually owned homes will be a desirable and stabilizing influence on American democracy, one most important economic principle cannot be evaded. Gross cost is an all important element.

About two years ago, in this same city, I sat in a large gathering of local business people assembled for the express purpose of discussing ways and means of providing low cost homes. While visiting all parts of this country on electrical industry matters for the past many months, there has been an excellent opportunity for me to learn how various local builders have been endeavoring to reduce the cost of housing.

MR. MORTON

I have reached one definite conclusion. The mechanical assembly of a shelter is tradition bound and custom dictated. Until recently there hasn't been a major change in over 300 years. Since the early colonization of this country, methods of home assembly have remained unchanged.

In May, 1924, there was passed by the New York State legislature a little known act which constituted a body corporate by the name of the John B. Pierce Foundation. A few of you have since heard a little about it. This corporation was established for "receiving and maintaining a fund or funds, administering the same, and applying the principle and income thereof, . . . to promote research, educational, technical, or scientific work, in the general field of heating, ventilation, and sanitation, for the increase of knowledge to the end that the general hygiene and comfort of human beings and their habitations may be advanced. . . . "

A long series of test houses were built involving trials of radically new ideas of construction. However, it was not until July, 1939, that a test model seemed to approach the rigid specifications and hopes of the Trustees of this Foundation. This success was achieved after exhaustive study of household customs and living habits.

Subsequently, Experimental House No. 2 was built, incorporating minor improvements. Finally, a village of 12 newly designed units was constructed, and the houses rented to families of average class.

This final stage of experimentation is now completed. Reputable builders are being licensed to duplicate these patented homes. For this reason, you should become acquainted with the anticipated results, because the use of electrical energy plays such an important part in the ultimate success.

The entire house assembly is unique and a departure from all traditional practices. The principal units in construction are 20 wooden girders which encircle the house above and below the windows. Sheets of 5/8-in. phenolic

(*Continued on page* 301)

ELECTRICAL EQUIPMENT IN KITCHENS IN THE PIERCE FOUNDATION HOMES

Since the house's heating system does not generate hot water, a 10 gal. electrical unit is provided for that purpose under the kitchen counter and directly behind the water closet where it is handily connected to the plumbing system. This heater is large enough to supply hot water for clothes washing, bathing, etc., and would be turned on only when required. Water for such "off-peak" requirements as dish washing would be heated in a tea kettle equipped with an electrical heating unit. Water for floor washing would be heated in a galvanized pail similarly equipped. Result: no waste of hot water, and a lower electrical bill.

In addition to a small range, the all-electric kitchen includes a refrigerator which makes no ice cubes and has a lid instead of a door. This unit is low enough to serve as an additional counter for the preparation of food. All three major pieces of electrical equipment were designed particularly for use in low cost houses by manufacturers' engineers in cooperation with the Central Hudson Gas and Electric Company and the Foundation. In addition to these developments other well known low cost ranges and refrigerators have also been used.

A tabulation of energy consumption for nine of these homes in the "village" at High Bridge, New Jersey, is as follows:

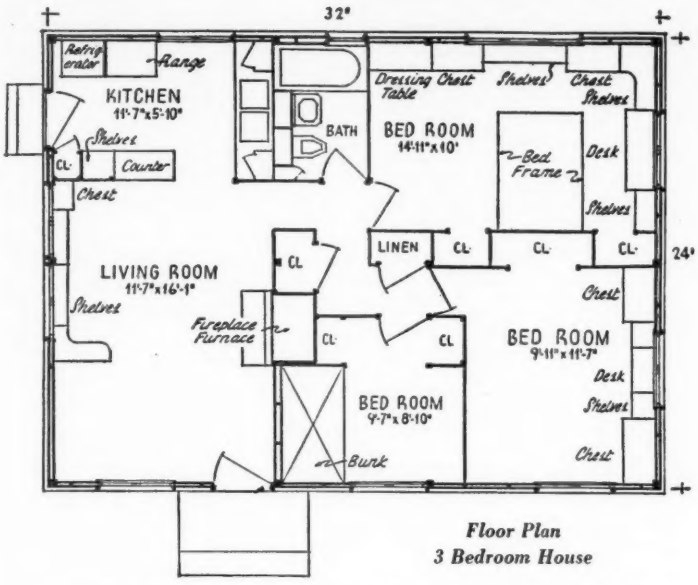
House No.	*Kwhr*	*Size of Family*
1	3720	5
2	2580	3
3	3444	2
4	882	1
5	4968	3
6	3876	3
7	3881	3
8	3312	3
9	4560	3

Average Annual Use—3469 Kwhr
Average Family Size—2.9

All materials used by the Foundation were of the best and in keeping with the object of the experimental research.

Living-dining Room with Built-in Furniture in one type of Pierce Foundation house.

Dining end of living room features plastic surface wiring, chair height, with outlets every eight inches.



Floor Plan
3 Bedroom House

Standard floor plan of the three bedroom house. Overall dimensions of this single floor arrangement are 24 ft x 32 ft. There are two other "standard" plans—a two-bedroom single floor plan and a three-bedroom two-story arrangement.

(*Continued from page* 299)

plywood, 4 ft. deep, act as girder webbing.

The parts are shop cut to dimensions —much as a jig saw puzzle is made—only to fit together perfectly in the end. Exterior panels and exposed wood members are made from phenol impregnated plywood and coated with paint at the fabricating shop.

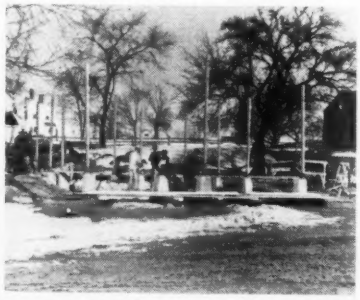
The building foundation consists of a dozen concrete piers with a curtain wall between set 3 ft. below grade. No basement is needed. A large share of the furniture is built into place.

After home buyers have made the down payment, few in the lower income group can financially handle the new furniture, rugs, accessories, appliances, and other such incidentals. As a result, the pleasure of home ownership is partially destroyed. The inclusion of most of these additional items can now be included at the time of occupancy and financed with the house.

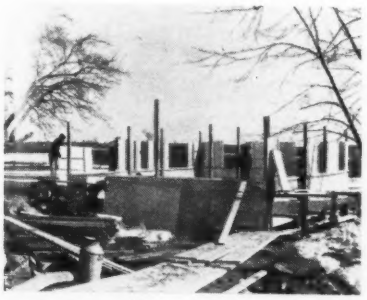
In order to strictly comply with the stipulations for which this research was undertaken; namely, "that the general hygiene and comfort of human beings be advanced," it was early recognized that electrical energy would ultimately play a major role. A separate electrical research division has accordingly developed innovations in the art of wiring and the shape, size and performances of major and minor electrically operated appliances and equipment.

The few homes already constructed are heated with oil burning equipment—all other functions are performed electrically. Cooking, refrigeration, and water heating are done by simplified editions of what has been customary practice. Equipment has been developed by established appliance manufacturers, in conjunction with and specifically for the Pierce Foundation. The past year's record of performance and use is most satisfactory, and sales people of this convention will want to get more complete experimental data.

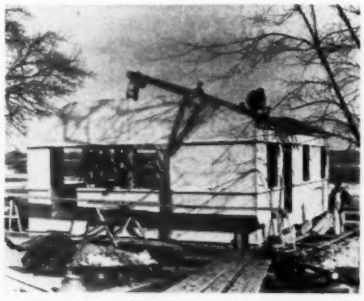
The average electrical consumption for nine homes has been 3469 kwhr per an-



8:10 a. m., columns on piers



11:20, panels between windows



2:45, rafters atop upper girders

9:50, joists inside lower girders

1:20, beam with joist clips

4:55 house enclosed

These pictures indicate speed of construction of the Pierce houses.

num. The average size family consisted of two and nine-tenth (practically three) members. The cost of heating in northern New Jersey was less than $50.00 for the season. This was done with improved oil burner equipment. It is entirely feasible that comparable costs can be equalled with gas heating equipment now available. This, for combination gas and electric companies, is another market for expansion.

Just a few comments on the adequacy and economy of the interior wiring of these homes, because they comprise some very clever innovations and the use of developments in the plastic industry.

Copper tubes are rigidly supported in a plastic housing. It is a "unit" system, wherein the sections fit together like sections of children's toy train track.

A more generous size of copper conductor; the elimination of rubber or other insulating coverings; the mounting of rigid tubes or rods of copper in strong phenolic plastic housings; the provision of a style suitable for surface mounting and generous outlets are the basic changes in the new wiring system soon to be produced by Pierce Laboratory, Inc., a separate corporation organized to work with all parts of the electrical industry that are vitally interested in advancing standards of living through more effective and convenient use of electricity.

Design details incorporated into the new plastic surface wiring system overcome all of the following former difficulties experienced in other forms:

(a) Grounding to metal enclosures.
(b) Current limited by insulating coverings.
(c) Difficulty of providing additional outlets.
(d) Undersized copper.
(e) Poor electrical joints at outlet boxes and devices.
(f) Insufficient mechanical protection of conductor insulation.

For many months the services of Electrical Testing Laboratories have been engaged to test these new designs. Their tests indicate that conservative continuous loading up to 35 amp without undue heating is possible. Extreme loadings of 65 amp (final branch circuits) will introduce no hazards whatsoever—this as compared to limit of 15 amp with methods and materials now available.

This new design serves a dual purpose when installed—that of the decorative molding for the base board and convenient and adequate electrical outlets.

(An illustrated brochure containing a detailed explanation of the house construction, the interior appurtenances, electrical equipment, and wiring will be mailed upon request to the Edison Electric Institute.)

As to total costs: The three-bedroom house complete with built-in furniture, screens, storm sash, heating plant, electric range, refrigerator, and water heater totals $2,079. Garage and breezeway can be provided for an additional $300. The same size house with a two-bedroom floor plan is approximately $200 less. To this must be added only the land, say $350, and the builder's overhead and profit.

Thus, for $3,000 to $3,500, a low cost electrified home can be made available to the low income family. Proper exploitation and good merchandising may ultimately effect costs closer to $2,500 total.

The total weight of this house is 15,800 lbs. A 10-ton truck can haul it, in the unassembled form, to the erection site. Recently, one of these homes was trucked from Bound Brook, N. J., to Syracuse, N. Y. (250 miles), over Sunday night. Erection started on Monday morning—and on the tenth day following it was complete, painted and ready for occupancy.

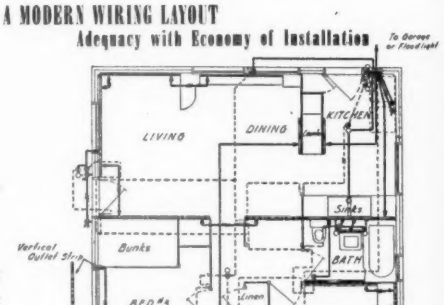
Low cost housing may prove to be the approaching industrial activity to cushion the war's aftermath. American ingenuity should be able to arise to the occasion and very shortly produce the low cost home comforts for that mass population which has heretofore been denied these privileges.

Involved in the complete exploitation of low cost housing projects, such as the one briefly explained, are aspects of low finance, industrialism and economics. Bankers, I believe, are pretty much reconciled to time payment plans. Statistics show that low income earners are as reliable in meeting their financial obligations as those in the higher brackets. When a $25 worker is able to purchase his own complete electrified home, there will become available an immense new market for material and labor—and electrical energy—within the boundaries of these United States of America.

Once in every generation or so, in every new era of development and economic adjustment, there arises some new activity, which assists in meeting pending crises. Realistic endeavor must be based on new concepts or the expanding of older ones, determined by constructive thinking in the field of research and experimentation.

When anyone really desires to accomplish a purpose, organization, management, and planning are necessary. After successful technical answers have been obtained, intelligent exploitation is in order. Because this particular low cost housing development offers load building possibilities for the electrical industry, it seemed apropos to bring it to your attention at this convention and to enlist your interest in this joint development.

Truly, such an industrial possibility is worthy of action. The low cost electrified home can be a highly desirable Design for Living in America.



Modern Wiring Layout in a Low Cost Electrified Home.

Illustrated descriptive information on the Low Cost Electrified Homes discussed in this address may be obtained from the Edison Electric Institute, 420 Lexington Ave., New York.

Progress in Accident Prevention

By W. R. Smith

Chairman, Accident Prevention Committee, E.E.I., 1939-1941

Statistics in general lack warmth and life. Such data as are presented in the graphs herewith showing the progress in accident prevention in the electric light and power industry since 1923 will be found to be an exception. Throughout the years over which this progress has been made, the various committees have made their contributions as they have emphasized the importance of statistics, of engineering and design, of operating procedure and work techniques, of executive interest and of employee training. It is fitting that we give recognition to those who have preceded and who have helped to lay the foundation on which the work of the Institute in this field can be built with confidence in the future.

WHEN the Accident Prevention Committee held its spring meeting in Chicago, May 8-9, 1941, a report was made by Mr. E. J. Kreh, subject sponsor for accident statistics, on data for the first three months of this year which had been submitted by 23 companies represented on the committee and having a total of 56,805 employees as follows:

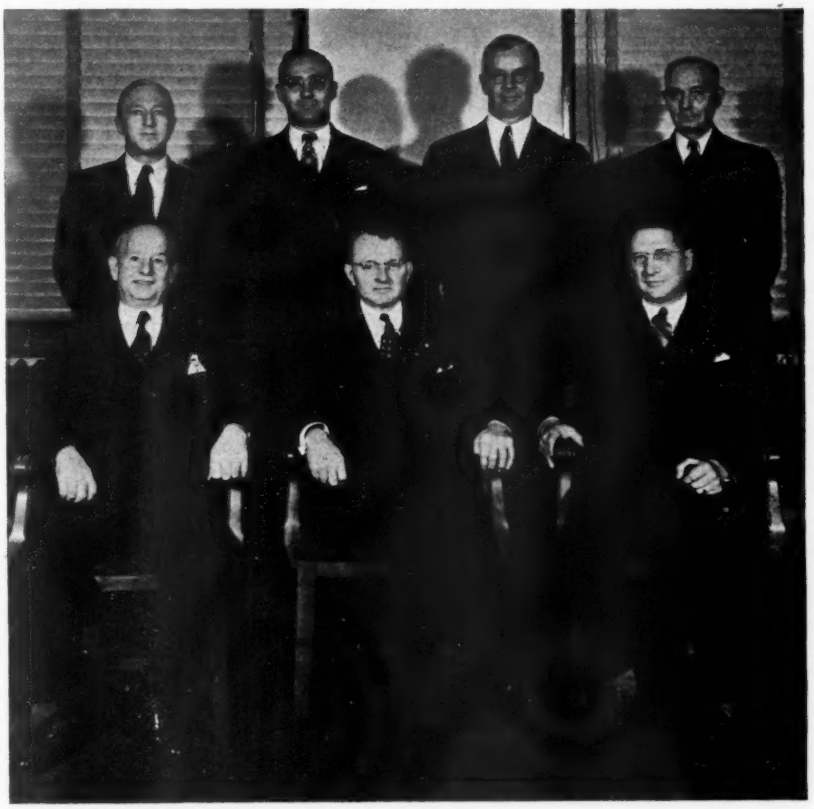
Fatalities per 1000 employees per year	None
Lost Time accidents per 100 employees per year	1.61
Days lost (actual) per 100 employees per year	29.61

It is appreciated that the results attained by this small group of companies cannot be considered indicative of industry results for the period but it is of interest to point out that whereas 23 is but 5 per cent of the number of companies reporting to E.E.I. annually, the employee figure is approximately 20 per cent of the total for all companies. These figures become significant, however, when they are compared with the results recorded on the industry trend curves presented in the graphs on the next page and suggest the possibility of even lower values being attained than have yet been recorded for all E.E.I. Companies.

The progress that is indicated by these curves over the period 1923-1940 is not considered by the Accident Prevention Committee to have resulted solely from its work and influence; but the Committee does have pride in the accomplishment of the industry and in any contribution that the committee may have made. Perhaps such contribution as has had been made and that will be made in the future can be shown to be the result of discussions of experiences by those making day by day studies of the various kinds of accidents happening in our industry and out of which gradually come a clearer understanding of the fundamentals of this matter and of the underlying basic causes of a majority of all accidents.

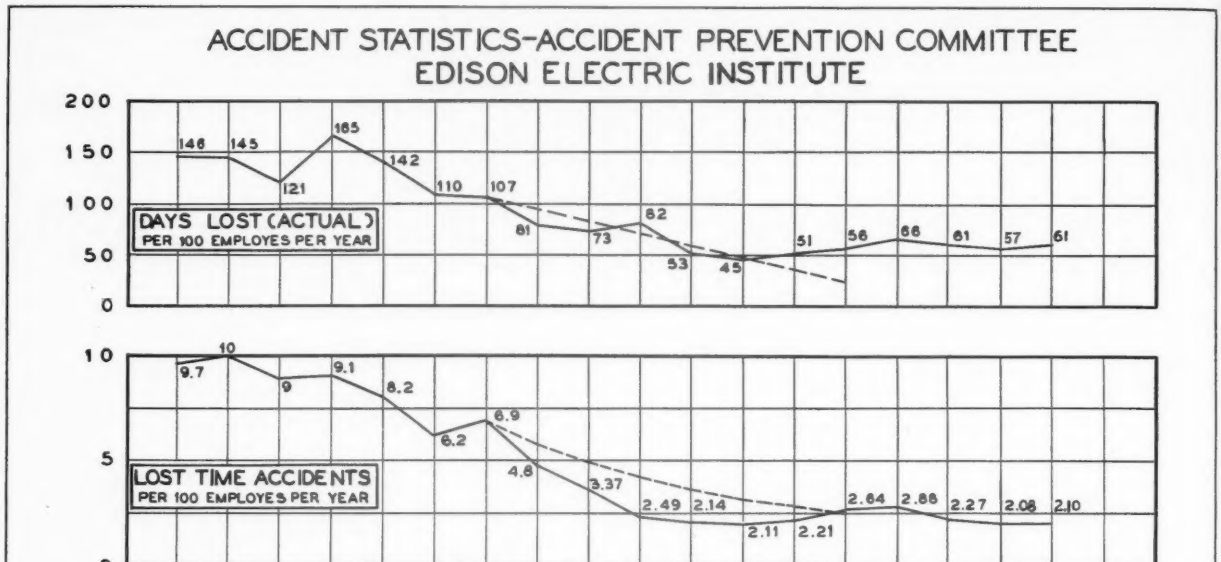
Last fall there were present at the fifteenth meeting of the Committee, held at Institute Headquarters, a number of those who, in previous years, as chairmen of this Committee, kept open and made easier for travel, the trail that had been blazed by those who had preceded them as chairmen of the earlier N.E.L.A. committees. The presence of those leaders of past years was inspiring to the committee and evidenced the interest still held for the work of this group. Out of the discussion thus made possible, it is deemed important to point out that the future progress of our accident prevention work and the continuance of a downward trend in our statistical curves depend upon a full understanding on the part of all who are in any way concerned with the control of accidents as to the evolution that our thinking has undergone and where we find ourselves today.

It was perhaps natural that, in the early days, there should have been those



Past Chairman and Secretary of the Accident Prevention Committee, NELA and EEI

Seated: E. W. Gorry (1932-1933), New York Edison Co. (Cons. Edison Co.); W. R. Smith (1939-1941), Public Service Elec. & Gas Co.; C. R. Beardsley (1928-1930), Brooklyn Edison Co. (Cons. Edison Co.). Standing: L. M. Shadgett (1937-1939), Georgia Power Co.; W. A. Buchanan (1930-1932, 1933-1937), Appalachian Elec. Power Co.; K. R. McKinnon (1926-1928), Ebasco Services Inc.; A. B. Campbell, Committee Secretary, E.E.I.


ACCIDENT STATISTICS-ACCIDENT PREVENTION COMMITTEE
EDISON ELECTRIC INSTITUTE
DAYS LOST (ACTUAL)
PER 100 EMPLOYES PER YEAR
146 145 121 165 142 110 107 81 73 82 53 45 51 56 66 61 57 61
LOST TIME ACCIDENTS
PER 100 EMPLOYES PER YEAR
9.7 10 9 9.1 8.2 6.2 6.9 4.8 3.37 2.49 2.14 2.11 2.21 2.64 2.88 2.27 2.08 2.10
FATALITIES
PER 1000 EMPLOYES PER YEAR
1.7 1.6 1.7 1.7 1.4 1.4 1.37 1.21 .97 .72 .66 .64 .59 .71 .76 .67 .57 .57
1923 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
Y E A R S
INDICATES OBJECTIVES SET UP BY N.E.L.A. ACCIDENT PREVENTION COMMITTEE IN 1929.
GIVES ACTUAL RESULTS REPORTED ON A COVERAGE OF APPROXIMATELY 90 % OF INDUSTRY'S EMPLOYES.

who looked upon industrial accidents as happenings for which the employee was solely responsible and who, therefore, were inclined to consider conditions in the industry as not bad from the standpoint of responsibility that might rest upon them or their companies. Such attitude, as sincere as it no doubt was, could not be expected to respond to the possibilities of cooperative effort for accident prevention through committee activity. It was fortunate, however, for the industry that there were those who believed that only good could come from such effort as was contemplated and that the industry owed it to itself to do all that it could to keep those who were members of it.

That the earliest efforts to reduce accidents in our industry should have been predicated upon purely humanitarian considerations is understandable and consistent, no doubt, with the experience in many another field of activity. Such considerations, as worthy as they are in their own right, have in no sense been lessened in importance by that which has been learned in the years that have passed since first efforts were made. Rather they have been strengthened by the ever increasing realization of the fact that all aspects of industrial accidents occasion economic loss and that the prevention of such losses, especially those that affect the family of the injured and his own future earning power, have humanitarian aspects that transcend even the prevention of suffering and disability.

As the work of the committee went forward, the need for statistics on the true condition in the industry was becoming apparent and there were selected and endorsed by all concerned the bases upon which information would be requested annually from all companies. Such information does not constitute an objective of itself but provides a yardstick by which individual companies can measure their own performance and furthermore shows in a practicable, readily understood way, the progress that is made in the industry from year to year in the field of accident prevention.

Interest in the causes of accidents that were happening and their location led later to studies of this nature over a period of several years. Those studies showed that by far the greatest percentage of the total accidents were being experienced in the construction and maintenance of the overhead lines. More recently there have been indications that this condition no longer exists generally throughout the industry and that the improvements in construction details and in arrangements, together with the development and standardization of work procedure, practices and techniques, have so benefited the work in this field that the accident experience is approaching that of well-ordered work anywhere. "Employee Practices" were shown to be the "cause" of a large majority of all happenings and it is with this group that we are vitally concerned today.

The fact that the largest percentage of our accidents today are chargeable to "Employee Practices" would appear to vindicate those who at an earlier day held the opinion that accidents were due

to human failure about which little could be done. The difference between that day and this, however, lies in the attitude now held toward such accidents and furthermore much has happened that in effect negatives the truth of the statement when it was first made. Had this industry been content at that time to accept as unpreventable all accidents in which an employee was injured, on the ground that it was the injured's own act that was the sole "cause" of the accident, present day analysis would show something other than "Employee Practices" as principle cause. It is important to point out, therefore, that it has been out of the painstaking study of accidental happenings throughout the years that have come many of the changes in our arrangements and facilities in plants, substations and distribution systems. These changes and the improvement in procedure and work practices that have been effected at the same time have continuously eliminated the inherent hazards to as complete an extent as may be considered practicable. Each year we find fewer of the accidents to be due to inadequacies of design or of clearances or associated work conditions.

All that has been accomplished in the above respect and that must be continuously done if we are to maintain conditions in our industry as they should be, leave us with the large percentage of accidents under the heading "Employee Practices" and which embraces all happenings that are the consequence of usually unintentional acts of commission or omission on the part of our workers in various fields. Strange as it may seem, this is as it should be and is the inevitable consequence of the steadily advancing improvement in every detail of the modern electric light and power system. The difference between today and yesterday, when such condition might have been considered by some as not an obligation of management, is that we recognize that just as the elimination of inherent hazards had to be accomplished by a careful study of all factors so now this large number of accidents which still remain and which can all be shown to have the same common denominator —"human failure", will be effectively reduced only through an understanding of the conditions and circumstances, both physical and mental which produce them.

A comprehensive analysis of the above aspect of our accident prevention work is beyond the scope of this article. It is perhaps sufficient at this time to say that we have come to realize the importance of certain fundamentals as they relate to the general problem of developing accident prevention consciousness in the minds of all of our workers from executives through supervisors to the workers who perform the simplest task. The experience and work of the committee would seem to put the emphasis in the following items, the order of presentation denoting especially the sequence in which they must be developed rather than that any one is necessarily more important than the others in the accomplishment of the final result.

(1) *Executive interest.* Genuine interest on the part of the officials of the company in the accident prevention program and their endorsement of its principles and of company and industry activities that are related to it.

(2) *Rules and Procedure.* Carefully established operating procedure and rules defining safe practices and work techniques.

(3) *Employee Training.* Recognition of the importance of training workers in their particular jobs and as well in the fundamentals of good workmanship and work habits if such have not been already established on previous experience.

(4) *Mental Attitudes and Emotional Behavior.* Understanding of the fact that with conditions as they should be under (1), (2) and (3) our objectives will not be attained if we do not recognize the tremendously important part that is played in this entire program by the mental state of the employee and of how necessary it is that all supervisors understand this and be observant in order that they may detect any symptoms of anything unusual in attitude or behavior of those reporting to them.

The Accident Prevention Committee aims to make its consideration of these and all associated matters of benefit to all member companies. It is believed that this can be accomplished and service rendered in many other respects through the opportunity provided at its meetings in the exchange of ideas and experiences. Attendance at such meetings is not restricted to committee members, and representatives are urged to attend whenever they find it convenient. In no other one way can a particular company hope to profit more fully from the progress made in accident prevention in the light and power industry over the past twenty years than through making it possible for some member of its staff to attend meetings of this committee. It will always be shown that those who come seeking help will leave behind much that is helpful to others and thus is the cooperative spirit kept alive and stimulation given to those fundamentals upon which depend the advancement of even better records for our industry.

Home Service Women's Conference Planned By E.E.I.

A "PARADE of Demonstration Ideas" for women engaged in home service and lecture-demonstration work in electric utility companies will take place September 4-5, at the auditorium of the Electrical & Gas Association of New York, Inc., 480 Lexington Ave., New York City, the Home Service Committee of the Edison Electric Institute announces.

The need for a meeting at which all women in home service or home lighting work can assimilate ideas and material that formerly did not reach all persons in the field, and can exchange tested ideas that have proven successful, has encouraged the Committee to sponsor the Conference.

Demonstrations and presentations for all types of electrical equipment will fill the two-day program. Materials and ideas will be adaptable to all types of groups, from the small select group in the customer's home, to the large club group and city-wide cooking school. Floor demonstrations and individual presentations will also be featured.

Home economists of manufacturers and others with advanced thinking along these lines will contribute to the "Parade of Demonstration Ideas." Leading talent in the electrical industry and from other fields will offer a continuously entertaining and instructive program.

New, streamlined techniques in numerous types of demonstration will make the conference of lasting value to every home service person engaged in lecture-demonstration work. New ideas, and new methods of presenting facts with which audiences may be familiar, will provide new material and fresh enthusiasm to aid in planning the 1941-1942 programs in local areas.

Registration at this Conference is open to home service women of all private utilities, and to women in other fields interested in this type of service. Persons engaged in lecture-demonstration work, and utility commercial women who can help increase sales through lecture-demonstration are cordially invited to view the modern ideas in demonstration material.

For information on the "Parade of Demonstration Ideas," address the Home Service Committee, Edison Electric Institute, 420 Lexington Ave., New York City.

Lightning Resistant 66 Kv Transmission Lines

By W. R. Metzger and E. R. Whitehead

Duquesne Light Company, Pittsburgh

Presented before a meeting of the Transmission and Distribution Committee, EEI, Chicago, May 7.

THE Duquesne Light Company recently completed rebuilding two 66 kv transmission lines, one 15.1 miles and the other 9.3 miles long, as part of a program for "Lightning Proofing" the entire 66 kv transmission system.

The system under consideration is essentially a ring, extending around the metropolitan district of Pittsburgh, and is comprised of approximately 120 miles of double circuit line on steel towers. These lines were built many years ago and do not embody such features as are considered essential today to resist lightning.

With the system becoming heavily loaded and with additional generating capacity being installed, it became necessary to critically examine the transmission system for load capacity and reliability.

It was found that the system was adequate, for expected loads and generating capacity additions, when rated on the basis of one circuit out of service at any time. However, an examination of outage records showed that the reliability of the lines was not as good as desired and, in particular, a sufficient number of outages were double circuit to necessitate considering a double circuit tower line out of service when figuring system capacity.

The records show that approximately six out of seven faults are due to lightning, and that for the system, twenty-four faults are due to lightning per hundred tower line miles per year and on the worst line this figure rises to 56.8. Of these faults about one third are double circuit.

It then became a choice of building new lines to parallel present ones in certain parts of the system or of improving the reliability of the present system. With the majority of faults due to lightning, it was evident that any substantial improvement of performance could be gained only by changes which would render the lines as nearly "lightning proof" as possible.

A complete analysis of the system was made to determine the degree of improvement that could be secured by various changes.

The basic theory underlying the calculations made in this study is that stated by Dr. Charles Fortescue in 1930 and since developed extensively by Mr. L. V. Bewley and others.

Briefly, the theory holds that line flashovers caused by lightning on high voltage circuits are the result of strokes terminating upon the conductor, the ground wire, or the tower. In the first case, the lightning current required for flashover is so low that it is permissible to assume all such strokes cause flashover. In the second and third cases flashover is dependent upon numerous factors, some of which are well defined and capable of accurate analysis, while others are indefinite and difficult to evaluate.

It will be immediately apparent that line protection falls into two principal phases:

1. Ground or shield wires must be located to prevent the termination of the stroke on a line conductor.
2. Assuming the stroke to terminate on the ground wire or tower, the various factors then governing must be coordinated to prevent flashover from tower or ground wire to the line conductor.

Field experience and laboratory tests yield conflicting conclusions with respect to the first, or shielding phase, while the theory of the second part is abundantly verified by subsequent performance of well designed lines.

Because our interest lies in the overall answer to the outage problem, it has been necessary to place an arbitrary valuation upon the effectiveness of various ground wire configurations with respect to shielding the conductors from direct strokes. For this reason, the part of the data relating to this part was separately identified in the results and may be readily adjusted at such time as a more satisfactory evaluation is possible.

The principal factors governing the line performance under the assumption of perfect shielding are:

Magnitude and Shape of Lightning Stroke Current

Quite satisfactory field data are available on the magnitude of lightning stroke currents, but very limited data have been obtained on the wave shape. Magnitude data used were that presented by W. W. Lewis and C. M. Foust in "Lightning Investigations—VII," A.I.E.E. 1939, in the form of a distribution curve showing the per cent strokes equalling or exceeding given current values.

Calculations were made for a lightning wave front of one microsecond and for a wave front of three microseconds. The results for the one microsecond front are presented as the more conservative.

Tower Footing Resistances

A sample of the tower footing ground resistances was obtained by actual measurements on 51 towers. From this sample the distribution curve of Fig. 1 has been derived for use in the computations. The actual sample curve has been arbitrarily extended in the direction of higher footing resistances in order to include the effect of a few high values which would undoubtedly appear in a larger sample.

There is no fixed relationship between meggered resistance and impulse resistance values. Test results indicate that the impulse resistance value varies from 35 per cent to 70 per cent of the meggered resistance value. The amount of reduction depends upon the character of the soil and the value of the current. This factor was retained as a factor of safety in the calculations.

Impulse Strength of Insulation and Clearances

The impulse strength of suspension insulator strings and tower air clearances has been standardized, and these values are used in calculations. Midspan impulse sparkover values are conservative extrapolations from data on long air gaps. Data on wood and porcelain combinations are available, and have been used to estimate the margin of safety between structural flashover and air clearance flashover at the tower. When wood arms are used the limiting impulse strength is normally assigned to the conductor-tower air clearance. Un-

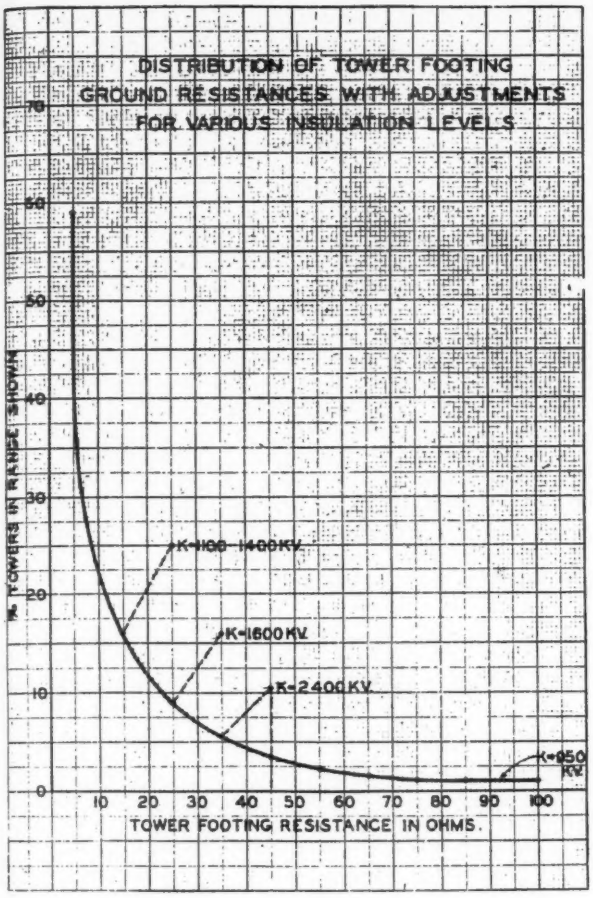


Fig. 1

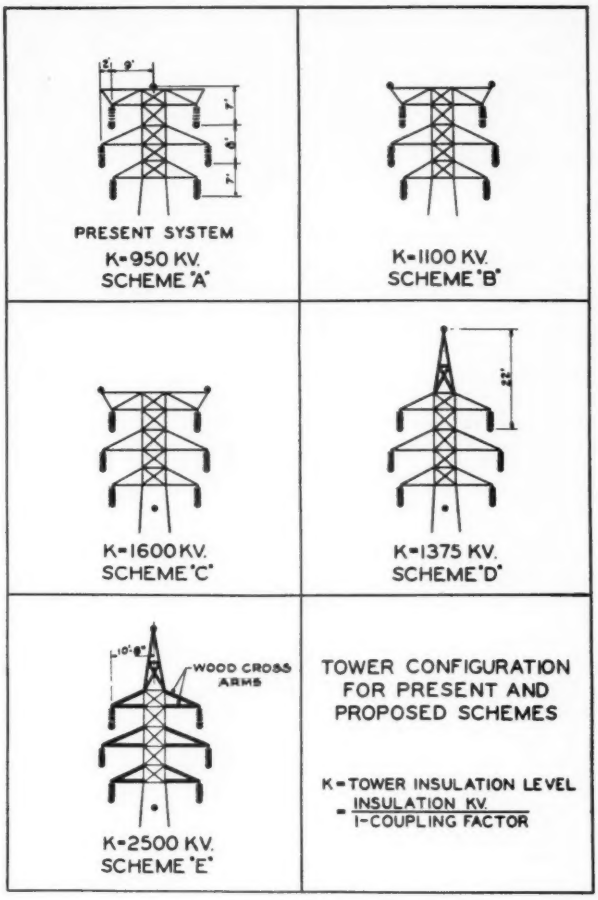


Fig. 2

der certain conditions and with some unseasoned wood arms this coordination will infrequently fail to obtain, but it is not structurally feasible to design for absolute coordination. Proper selection of seasoned wood should render structural flashover extremely infrequent. Moreover, the dual member wood arm design is such that the strength of the assembly is not seriously impaired even in the event one member is completely shattered.

Surge Impedance and Coupling Factors of the Line.

Surge impedance and coupling factors are calculated according to usual practice, taking into account a conservative corona effect.

Span Lengths

Span length affects the calculations by determining the time intervals elapsing before the parallel tower footing resistances of adjacent towers can aid the stricken tower, or ground wire point, by taking a share of the stroke current. All calculations are based upon 800 foot span length, which is conservative for our system.

The methods used in calculating line performance have been selected in the light of theory, experiment, and field experience with well designed lines, and are believed to embody all principal factors to a satisfactory degree of engineering accuracy.

Description of Schemes Considered

A study of the basic principles and methods of improving line performance from lightning disturbances indicated that certain changes in arrangement of ground wires and phase conductors would be required to achieve the improvements in shielding and insulation levels desired. The structural limitations of our present towers were investigated and it was found that the towers are strong enough to make the following changes without a major rebuilding of the entire tower:

1. Add a second overhead ground wire or raise the present one fifteen feet to secure the desired shielding level. Raising the present ground wire increases the phase to ground wire clearance and improves the midspan flashover performance.
2. In addition a ground or coupling wire can be added, under or near the elevation of the bottom phase wires, to raise the coupling factor.
3. Any increase in phase spacing to permit the use of longer insulator strings would require a major rebuilding of the towers. However, the increase in insulation can be secured by the use of wood instead of steel in the crossarms.

Following is a brief description of the various schemes considered. Fig. 2 shows the arrangement of lines for rebuilding present towers.

Scheme A

Present System—Included for comparative purposes and to determine to what degree the various parts were contributing to the high failure rate.

Scheme B

One overhead ground wire was added to the present system and all high tower

footing resistances were reduced to a maximum of 25 ohms. This arrangement gives excellent shielding but the phase to ground wire clearance is insufficient for mechanical reasons and gives poor midspan flashover performance.

Scheme C

Same as Scheme B except with the addition of a third ground wire under the phase conductors. The maximum tower footing resistance permitted for this scheme is 35 ohms. The same disadvantages are present here as in Scheme B. The lower ground wire improves the coupling factor so that an increase in effective tower top strength of almost 50% is achieved.

Scheme D

The present ground wire was raised fifteen feet and a new ground wire installed under the phase conductors. The steel crossarms are retained. The maximum tower footing resistance permitted for this scheme is 25 ohms. Raising the ground wire gave satisfactory shielding and improved the midspan flashover performance.

Scheme E

Same as Scheme D except the steel crossarms were replaced with wood and the maximum tower footing resistance is 45 ohms. This change added very materially to the insulation strength of the towers.

The wood crossarms are of dual construction for all members and are so designed that the splintering or failure of any member will not affect the support of the line. Any wood member that fails can readily be replaced at some convenient time after the storm. From experiences of other companies most failures of this type appear on new construction and after a period of a year or so the percentage of failures becomes almost negligible. Properly seasoned wood will do much to eliminate these early failures. The wood selected is treated fir with a cross section of 2 in. x 4 in.

The hardware developed for both ends of the wood members works on a double wedge principle. The wood is placed under compression at the point of attachment for both tension and compression forces on the arm. This arrangement increases the strength of the assembly very materially and will maintain it with any shrinking or swelling of the wood.

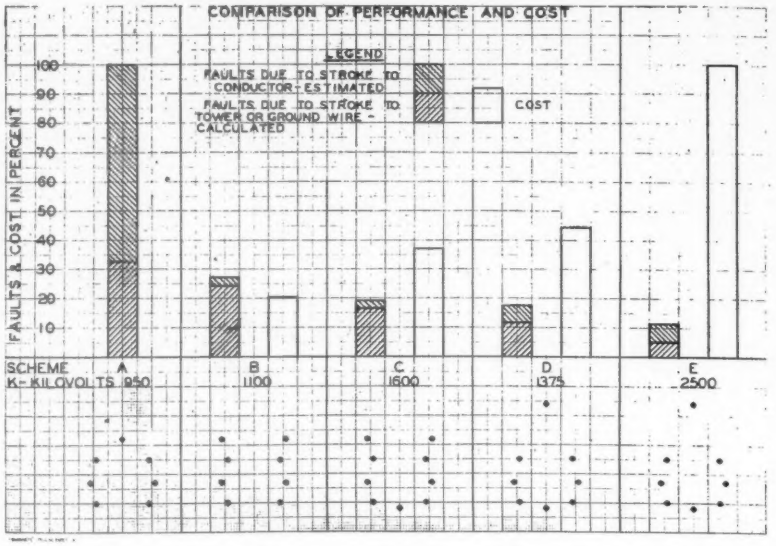


Fig. 3

In addition, the outage time on our transmission system, due to painting, averages about 18 per cent of all maintenance outage time. With wood arms and galvanized malleable iron fittings, this outage would be eliminated as the tower and basket could be painted while the lines are in service and with no need for the workmen to go outside of the tower basket.

Underline Ground Wire

Schemes C, D, and E all show the installation of a ground wire installed near the elevation of the lower phase wire.

For various reasons the extension of buried wires any appreciable distance from the tower base was considered objectionable. In addition, a study of Fig. 1 shows a reasonably low level of tower footing resistances since 59 per cent of the towers are under 10 ohms. The rest may be reduced to satisfactory values by either ground rods or moderately short (50 feet) radial wires from the base of the towers to ground rods at the ends. The idea of a continuous buried counterpoise was therefore discarded.

As shown in the Appendix, see Appendix I, high coupling between ground wires and line conductors is theoretically just as important as low ground resistance.

Since structural limitations made it necessary to seek proper shielding and midspan clearance by means of raising the present ground wire, the coupling factor fell somewhat below that for the old construction or from 0.25 to 0.19.

In order to appreciate the desirability of giving suitable weight to this factor it should be noted that no difference in potential could occur across the insulator strings if the entire conductor system were enclosed by a metallic cylinder supported by the tower. The addition of any ground wire is equivalent to adding a segment of this theoretical cylinder.

The location of the upper ground wire was, of course, dictated by the need of adequate shielding and proper midspan clearances while that of the lower one was determined as the location which would give the greatest increase in coupling factor.

As applied in Schemes D and E, the addition of the underline ground wire raised the minimum coupling factor from 0.19 to 0.48. Applying these values in Equation 1 indicates an increase in effective impulse strength of the tower insulation of about 56 per cent. Economically, this increase is large as compared with the cost of attaining the same results by other methods.

We believe this design embodies the first extensive application of the underline ground wire as a deliberate design feature based on the direct stroke theory of preventive lightning protection.

Performance

Performance calculations were made for all schemes shown. The chart shown in Fig. 3 gives a comparison between schemes in terms of faults for one of the lines of the system. The expected outages are shown divided between faults due to strokes to conductor, or shielding failures, and faults due to strokes to ground wire or tower. This

division was made due to the difficulty of an exact analysis of the first part even though the values are believed to be quite accurate. This chart also indicates the relative costs of the rebuilding schemes.

A study of this chart, in connection with the details of the various schemes given before, reveals some very interesting facts. In Schemes B and C, which were eliminated from consideration for mechanical and poor clearance reasons, the major improvement in performance is due largely to the reduction in the number of faults due to poor shielding with some improvement due to better coupling and improved ground resistance values. In Scheme D the shielding is not estimated to be quite as good as in Schemes B or C but the calculated performance due to strokes to the tower or ground wire system is much better because of improved midspan clearances, good coupling, and good ground resistance values. Another advantage of Scheme D is that it can readily be changed to Scheme E at some later time merely by the addition of the wood arms. The performance of Scheme E is improved over Scheme D through the direct increase in insulation afforded by the use of wood arms.

On the basis of these facts, Schemes D or E will be employed on any rebuilding work. The choice between them will depend on the importance of the lines to the system and on experience which will be gained on the first ones.

The lines rebuilt this past year were in accordance with Scheme E as they are vital links to the system and the utmost in performance was desired. It is expected that it will be impossible to get these lines out of service for further work at some later time. Another line may be rebuilt this year in accordance with Scheme D which will allow the questions of shielding and coupling to be studied further.

APPENDICES

APPENDIX I—UNDERLINE GROUND WIRE

For a stroke to the tower, the fundamental equation governing insulator flashover is

$$(1\text{-}C)\,(L_p + R)\,I + e_i + e_s = E \quad (1)$$

where
- C = coupling factor between line and ground wires
- L = tower inductance
- R = tower footing resistance
- E = impulse strength of insulation at specified time
- I = tower current as a function of time (negative)
- e_i = positive induced voltage on line wire
- e_s = assumed system voltage at instant of stroke
- $p = \frac{d}{dt}$

For most practical design studies, it has been customery to neglect the tower inductance, e_i, and e_s as of secondary importance. Equation (1) then assumes the familiar form

$$(1\text{-}C)\,RI = E \quad (2)$$

$$SRI = E \quad (3)$$

where $S = (1\text{-}C)$

Equation (3) shows that the S factor and the tower footing resistance enter the problem theoretically on an equal footing with R, yet little attention has been given to methods of reducing S by increasing the coupling factor. On the other hand, intensive efforts are usually made to reduce the tower footing resistance to low values. In order to appreciate the desirability of giving suitable weight to this factor, it should be noted that no difference in potential could occur across the insulator string if the entire conductor system were enclosed within a metallic cylinder supported by the tower. Fig. 4 shows the calculated coupling for eight ground wires distributed as elements of such a theoretical cylinder. The values are plotted for the lowest phase wire, and are given for three different assumptions as to corona. For simplicity of calculation, equal ground wire charges are assumed.

The increase in coupling factor caused by the addition of No. 2 ground wire is greater than that for any other element except No. 8, which is ruled out for both physical and electrical reasons. Further increase in coupling is structurally impractical and uneconomical, since the coupling rises very slowly toward the limiting value of unity.

In the more exact calculation for design purposes, the coupling factor for the combined direct stroke shielding wire and the lower coupling wire was 0.48 or an S factor of 0.52. Thus Equation (3) shows that the current to cause flashover is increased 56 per cent by the addition of the lower ground wire. The ability of the tower top to withstand lightning current is represented by a factor K which takes into account the actual impulse strength of the line insulation and the overall coupling factor, or

$$K = \frac{E}{S}$$

Flashover is then governed by the equation

$$IR = K \quad (4)$$

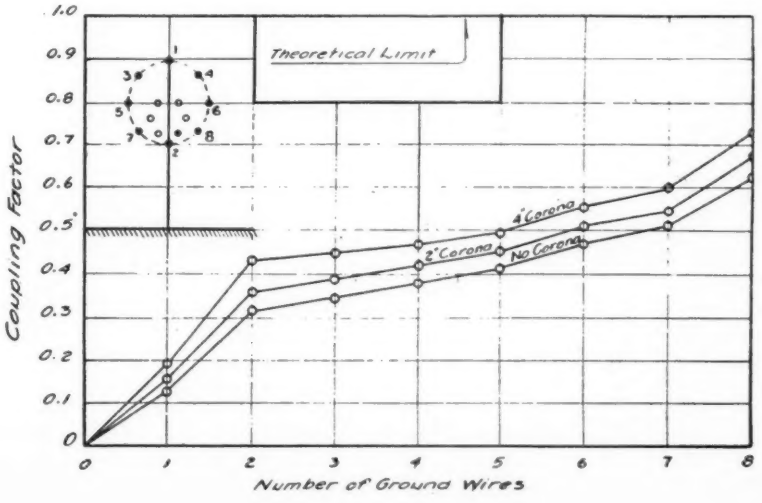


Fig. 4

APPENDIX II—LINE WIRE INDUCED POTENTIALS

As mentioned in Appendix I, the usual design equation neglects three factors of secondary importance. These are the tower inductance, the system line to ground voltage at stroke incidence, and the positive potential on the ground wire caused by the collapse of the negative charge of the cloud.

It has been shown by Mr. L. V. Bewley that the rate of cloud discharge is the most decisive factor in determining the magnitude of positive voltage induced on the line wires as a result of the negative lightning stroke. For a cloud height of 1000 feet, the equivalent rectangular bound charge is 2000 feet in length. These conditions permit the computation of the positive potential in a simple manner.

Fig. 5 shows the stroke current discharging the cloud through the tower, and illustrates the positive voltage induced on the line conductor. Choosing one microsecond time increments, the first increment of charge removed from the cloud is assumed to discharge instantaneously at one half microsecond, releasing the voltage indicated. Subsequent increments are similarly treated, and an envelope sketched in which represents the induced voltage available from the current wave selected. Such a procedure is sufficiently accurate for our present purpose. Since the charge increments are determined by the average current during the interval, the voltage is proportional to the stroke current and we may write

$$e_i = K_i I_s$$

If we assume a constant ratio between the stroke current and the tower current, then we may write further

$$e_i = SR_i I_t = SR_i \frac{I_s}{1.8}$$

$$R_i = \frac{1.8 e_i}{S I_s}$$

where R_i = equivalent tower footing resistance to produce the same voltage drop across the insulation.

$S = (1\text{-}C)$
I_s = stroke current
I_t = tower current
$I_s/I_t = 1.8$

This value of R_i may be added to the impedance of the tower footing and thus provide a means of taking the positive line potentials into account.

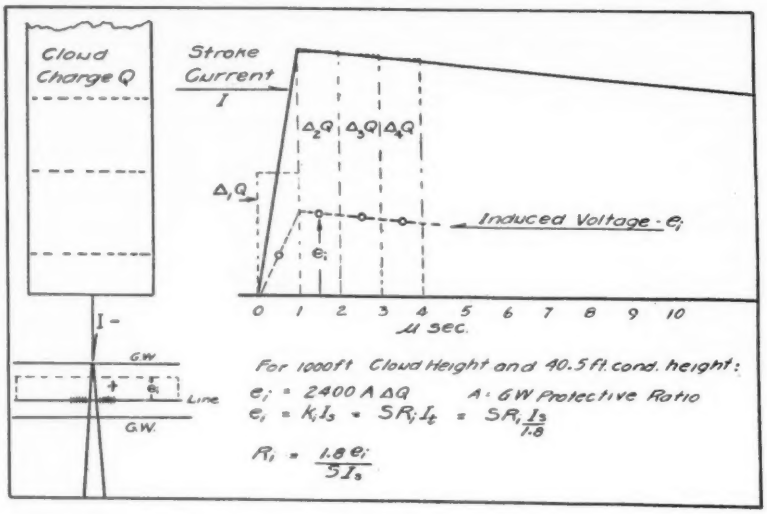


Fig. 5

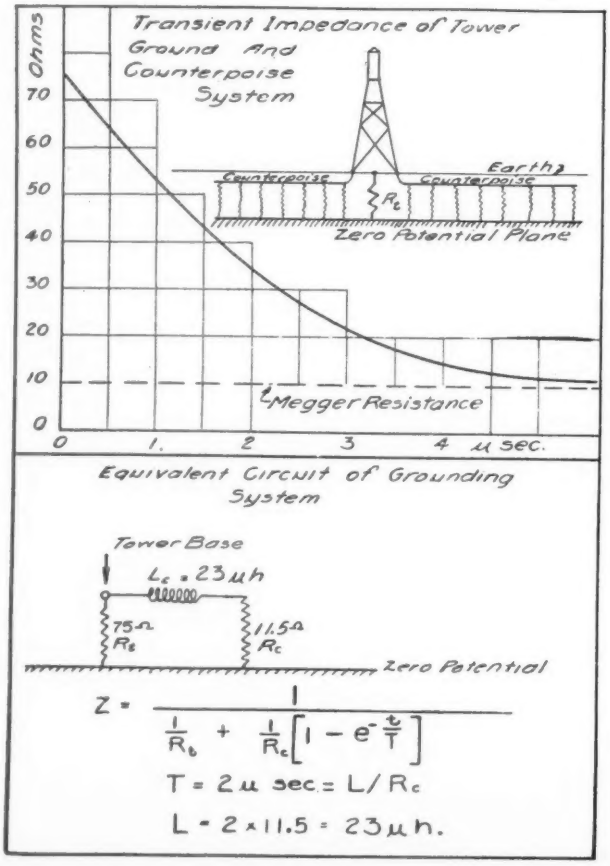


Fig. 6 (Appendix III)

APPENDIX III—SURGE IMPEDANCE OF TOWER GROUNDING SYSTEM

Fig. 6 illustrates the typical behavior of a tower base grounding system consisting of the tower footing resistance and two 500 foot buried counterpoise wires. An equivalent circuit exhibiting this behavior is shown together with the equation for the surge impedance.

Fig. 7 shows an equivalent circuit representing the resistance increment for induced line potentials, the tower inductance, the tower footing resistance, and the counterpoise surge impedance. A current I_t rising to 60 ka. in two microseconds is injected into the tower top, and the voltage computed for two cases. In each case the ultimate or "megger" resistance of the tower footing is 10 ohms, but in Case A this value is obtained through the use of two 500 foot buried counterpoise wires, while in Case B this value is obtained through a localized grounding system at the tower.

The insulation strength of the structure is represented by the dashed curve and is equal to the kilovolt-time curve for nine insulator units divided by (1-C) where the coupling factor C has been taken as 0.30. It will be noted that the voltage for Case A materially exceeds the insulation strength and will result in flashover, while that for Case B leaves a substantial margin.

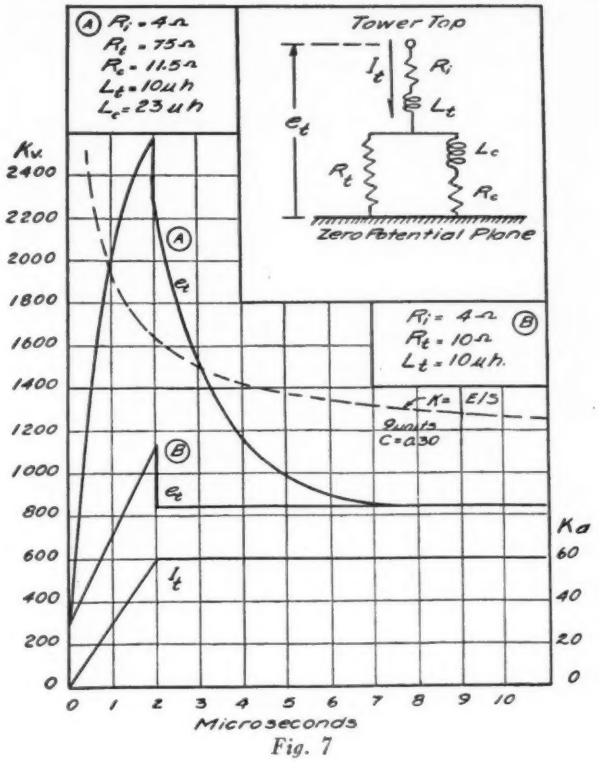


Fig. 7

Should this representation be approximately correct for lines with long counterpoises, then the actual flashover of the line would bear no fixed relation to the product of measured tower amperes and the measured tower footing resistance. Mr. S. K. Waldorf of the Pennsylvania Water & Power Company has presented data showing that flashover frequently occurs when the ratio of measured IR voltage to impulse strength is much less than unity.

Actual data on tower inductance and lightning current wave fronts are needed before these effects can be properly evaluated.

APPENDIX IV—SAMPLE PERFORMANCE CALCULATIONS

In the preceding appendixes, some of the more important factors affecting tower flashover have been discussed. As pointed out in the main part of this paper, a tower footing resistance survey indicated a high proportion of relatively low values, 84 per cent being under 30 ohms. It appeared, therefore, that local grounding methods such as radial buried wires up to 50 feet in length, terminating in ground rods would suffice where additional grounding was necessary. Equivalent circuits for counterpoises were accordingly not required, and there remained the questions of tower inductances and induced line potentials.

Nothing definite is known about tower inductances, but a rough estimate for the towers under consideration yielded a value of 7.5 microhenries. Fig. 8 shows the calculated tower top voltage for a severe stroke, and the tower strength-time curve for the design adopted. Minimum flashover voltage for a 1/5 wave corresponds approximately to the 3 microsecond point on the 1.5/40 curve shown. The effect of the sharp overshoot caused by tower inductance would be to shorten slightly the time of breakdown. It is usual practice to calculate line performance on the basis of tower footing resistance drop and the 2 microsecond tower strength. In order to discount the possibility of some tower inductance effect, it was decided to use the 3 microsecond strength in all calculations.

The effect of induced line potentials was taken into account through the method of Appendix II.

Table I illustrates the calculation of P_1, the per cent strokes to tower or ground wire within one quarter span from the tower, which result in insulation flashover:

TABLE I—TOWER STROKES

Footing Resistance	Per Cent Towers	Per Cent Strokes	Per Cent Flashovers
10	59	0.2	0.12
20	16	0.7	0.11
30	9	1.9	0.17
40	5.5	3.7	0.20
50	10.5	7.6	0.80
		P_1 =	1.40

The above calculation assumes that all footing resistances in excess of 50 ohms can be reduced to this value by appropriate means.

One half of the total number of

strokes is thus accounted for, and the remainder are assumed to terminate within one quarter span from midspan. Flashovers at midspan were computed in the usual manner except that the effect of induced line potential was included by adding a suitable increment to the surge impedance encountered by the stroke current. A refinement included calculation of tower flashovers caused by midspan strokes where the footing resistance was sufficiently high to permit such flashovers. Table II shows the calculations for midspan flashover:

TABLE II—MIDSPAN STROKES

Footing Resistance	Per Cent Towers	Per Cent Flashovers	Location
10	59	1.475	Midspan
20	16	0.400	Midspan
30	9	0.225	Midspan
40	5.5	0.150	Tower
50	10.5	0.390	Tower
	$P_2 =$	2.640	

The final probability of flashover for a stroke terminating on the tower or ground wire is

$$P = \frac{P_1 + P_2}{2} = 2.02\%$$

Assuming 98 per cent shielding by the elevated ground wire, and a stroke density of 1 per mile per year, we have

$$0.98 \times P + 2 = 1.98 + 2 = 3.98$$

flashovers per hundred miles per year.

Because of several intangible factors which we have endeavored to keep on the safe side, it is believed the above figure is somewhat high.

The longer of the two lines to which this construction has been applied is 15 miles in length. The flashover rate will be

$$0.15 \times 3.98 = 0.6 \text{ approximately}$$

or 1.66 years per flashover.

If one-third of these are double circuit, the line will be out of service only once every five years.

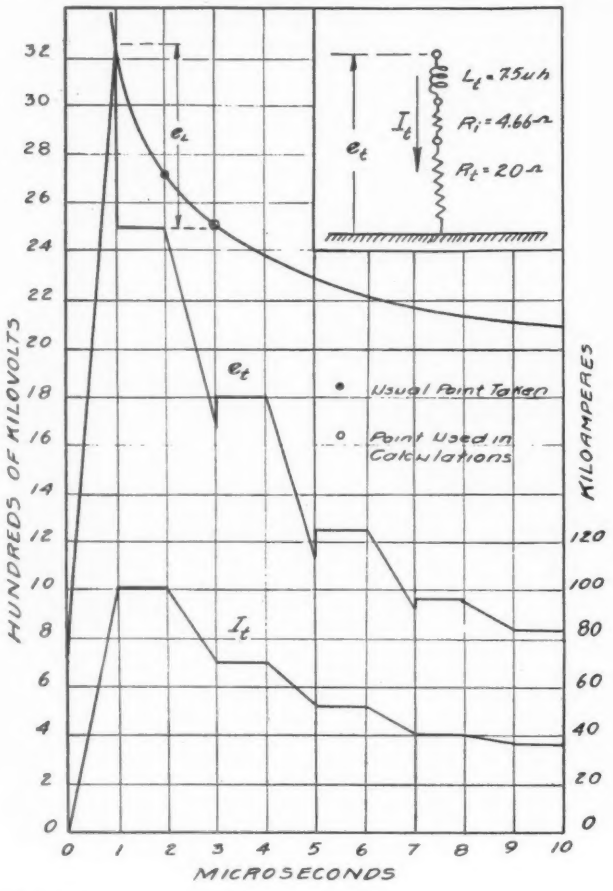


Fig. 8

EEI-NEMA Standards for Distribution Transformers

AT a meting of the EEI-NEMA Joint Committee on Standards for Distribution Transformers held in Pittsburgh on June 24, final revisions were completed on the Joint Committee's Second Report. As noted in the May BULLETIN, this report extends the range of standardization to include ratings of 100 kva and below. This Second Report has now been referred to NEMA and when fully approved will be made available in printed form as a Joint EEI-NEMA publication.

In the June issue of the BULLETIN, there appeared the Joint Committee's Supplement to its First Report (EEI Pub. No. G-6) embodying certain modifications in the First Report Standards for the transformer rated 25 kva and below. Reprints of this Supplement are to be made and will be available shortly from EEI headquarters for inclusion with the printed First Report.

It should be remembered that the standard features covered by both the Second Report and the First Report Supplement are not now available and should not be requested until announced by the manufacturers as available.

CL&P Co. Team Wins First Place in First Aid Contest

IN a state-wide first aid contest, designed to stimulate interest in civilian defense training, the Northern Division team of The Connecticut Light and Power Company won first place in the industrial division and tied for first place in all divisions with a Connecticut State Police team at the Connecticut Conference on First Aid and Safety, sponsored by the Connecticut Chamber of Commerce at the University of Connecticut, June 14.

Members of the C. L. & P. team were: Matthew Patterson, Robert Magliora, Stanley Radziewski, John McGuire and Foster Lees. Lees was a substitute for Lester Rundlette who was unable to compete. This team was trained by William V. Jones, a member of the Power Company Welfare Department, who also trained four other Company teams in the competition.

Thirty-six teams representing factories, police and fire departments, nurses' clubs, Boy Scout troops and other organizations competed.

McGraw Prize Paper

More Power Through Higher Operating Efficiencies of Hydro Electric Power Plants

By W. B. Hess and J. M. Mousson

MR. HESS

This paper, which won the First James H. McGraw Award for 1941, was written jointly by Messrs. J. M. Mousson and W. B. Hess of the Safe Harbor Water Power Corporation at Baltimore.

Mr. Mousson is a native of Switzerland and was educated at Zurich. He graduated from the Swiss Federal Institute of Technology in 1926 as civil engineer. He joined the Engineering Staff of the Pennsylvania Water and Power Co. in 1928 for project studies of the Safe Harbor development and since 1933 he has been Hydraulic Engineer dealing with various hydraulic investigations in the Mechanical and Civil Engineering fields.

Mr. Mousson was the winner of the first James H. McGraw Award in 1937.

Mr. Hess is a graduate of the Pennsylvania State College, B. S. in Mechanical Engineering, 1931. He has been employed in the Test Department of the Safe Harbor Water Power Corporation since 1931 and his work has consisted mainly of model turbine testing, field and index tests of Safe Harbor turbines, uplift pressure tests at the Holtwood dam, cavitation pitting resistance of metals, investigations and studies to improve operating efficiencies and increase in capacity.

MR. MOUSSON

This paper discusses the need for suitable apparatus to improve operating efficiencies of hydro electric power plants thereby increasing the power output through better utilization of available flow. An analysis of avoidable losses for one particular plant is presented as well as the solution to prevent these losses through a device assisting the station personnel to achieve better operating performance. Various types of apparatus suitable for other plants are discussed.

IN recent years there undoubtedly has been an ever growing demand for conservation and better utilization of our natural resources. This trend in thought stimulated a renewed examination of production and operating problems in innumerable fields of the nation's industrial activities. The power industry has been no exception, particularly so because other vital economic aspects such as higher taxes, reduction in rates, progressive labor laws and increased operating expenses, etc., gave an additional impetus to find ways and means for improved over-all economy. In addition, the demand for power has, for some time, been decidedly on the increase and, therefore, any measure or scheme productive of additional energy through increased operating efficiency was the more desirable, as it would help to satisfy at least to some degree this increased demand.

Engineers dealing with plant and system economy have been well aware that operating efficiencies of hydro electric developments are to some extent rather elusive and very difficult to control. Up to the present, two approaches have been explored quite generally and successfully. In the first place, tremendous strides have been made in the past decades to increase the mechanical efficiency and capacity of individual generating units, thus decreasing the number of units in one plant, simplifying operation and improving overall system economy. Secondly, there is the complex problem of load dispatching in accordance with intricate load studies based on individual plant and unit economies, system requirements, inter-connections, and river flows. This problem, which may or may not be complicated by combined steam or hydro generation for one system has been solved in most instances and is continuously re-examined with the addition of new capacity to a system.

In actual practice, however, there is between these two well defined and rational approaches, a link which so far has not been accurately controlled but has been subject almost entirely to the human equation, namely, the proper operation of the individual units. As it is this particular field with which we are here concerned, it may be well to point out that there is no intention of criticism regarding operating personnel. To the contrary, it is believed that plant operators are doing their utmost to keep inefficient operation at a minimum but at the same time they are unable to make

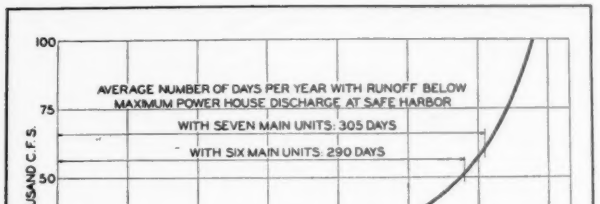


Fig. 1—Flow duration curve for Susquehanna River at Safe Harbor.

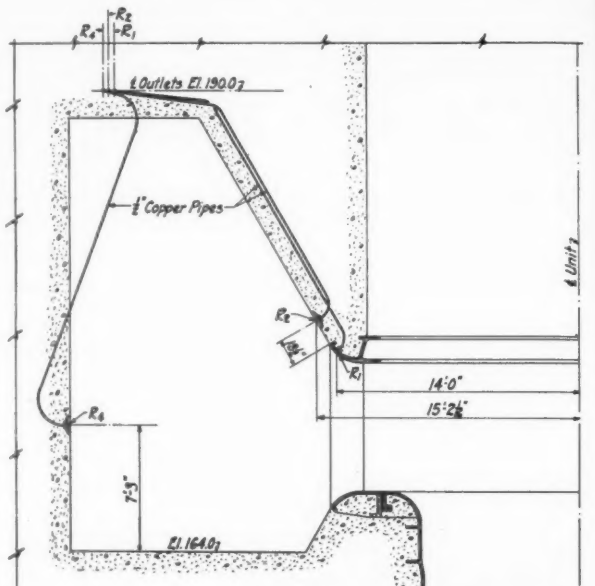


Fig. 2—Winter-Kennedy piezometer system of Safe Harbor main units.

further advances towards ideal operation without a physical yardstick in one form or other.

I. Hydro Economic Aspects of the Safe Harbor Development

At the outset of these investigations in 1939 the generating equipment at Safe Harbor consisted of six main units of the Kaplan type rated at 42,500 hp each under a head of 55 ft. Five of these units are operating at 109.1 rpm and one at 100 rpm, generating 3-phase, 60-cycle current at 13,800 volts and single-phase, 25-cycle current at 13,300 volts for Railroad supply, respectively. The two Francis type station service units initially installed are rated at 3,100 hp each under a head of 55 ft, operating at 180 rpm and generating 3-phase, 60-cycle current at 480 volts.

The attainment of high operating efficiency was particularly essential as during approximately 290 days the average river flow of the Susquehanna at the site was less than the station draft required with all six main units and two service units operating at maximum capacity, Fig. 1. With the placing in service of the seventh Kaplan main unit in October, 1940, also rated at 42,500 hp and generating single-phase, 25-cycle current, this period increased to 305 days or about five-sixths of a year.

During this portion of the average flow year, Safe Harbor is expected to take the peak portion of the load curve with the steam plants on the system operating on base load, allowing the hydro plants to carry the fluctuations. Since only a limited amount of water is available during this period, it is essential to generate at as high a plant efficiency as possible to secure the maximum number of kilowatthours for the peak portion of the system load. This energy is particularly valuable as it not only replaces energy generated by steam but also reduces the amount of steam equipment actually in daily service.

At times of rapid load change on the system, it is important that Safe Harbor respond quickly to the fluctuating load demands without wasting precious water. Utmost conservation of water is particularly necessary at times of unusual drought when it may be necessary to draw on the Safe Harbor pond to supplement the natural runoff thus enhancing the capacity value of the plant. Since the useful storage of this typical low head plant is necessarily limited and can only be secured at a very appreciable loss in head, efficient station operation is of utmost importance to secure sufficient capacity over a period of adequate duration. Only in high flow periods or about one-sixth of the average flow year, water economy is not of vital consideration because surplus water is being wasted by spillway operation. During this period the prime objective is to secure the maximum station output possible.

In the light of the above, it is evident that unit and station operating efficiencies are of prime importance and an almost ever present problem at Safe Harbor inasmuch as the station is running at 100 per cent utilization factor except over week-ends in the high flow season. Thus, any improvement in operating efficiency could be exploited immediately.

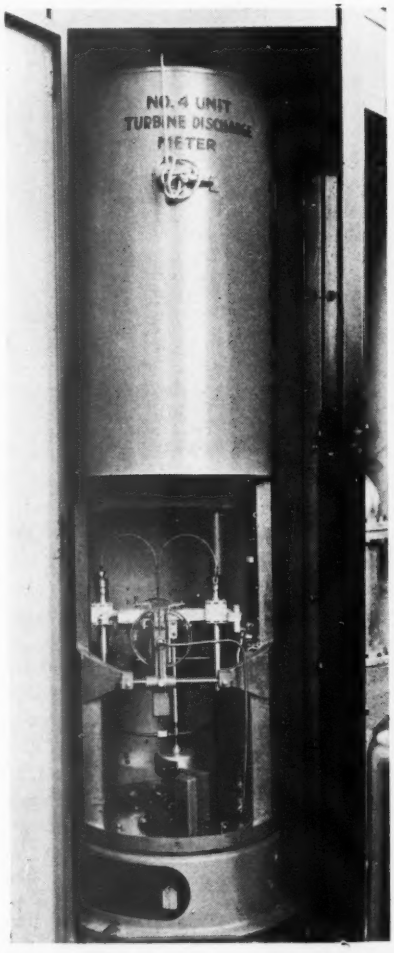


Fig. 3—Typical flow meter installation in unit gauge board cabinet.

II. Apparatus Available for Investigation of Safe Harbor Operating Efficiency

An investigation regarding operating efficiency necessarily required a comparison of power output with the hydraulic input. As at all modern generating plants, integrating unit output metering apparatus including a station total graphic wattmeter were available at Safe Harbor from the outset. An unusual input metering installation for individual units and total station discharge was placed in operation late in 1938. While it is not the purpose of this paper to discuss the many investigations on piezometers, flow meters, totalizing apparatus,[1]* etc., carried out over a period of years, a brief description of the input metering apparatus as actually installed is necessary.

Each of the main and service unit scrolls is equipped with a piezometer system,[2, 3] Fig. 2. The discharge through a turbine and the differential pressure of two opposite piezometer taps connected to a flow meter are related in accordance with the equation: $Q = C \times \sqrt{D}$, where "Q" is the discharge measured in cubic feet per second, "D" the differential piezometer pressure in feet of water and "C" a coefficient determined by means of calibrating data obtained during the turbine acceptance tests.[4]

* See List of Reference Literature.

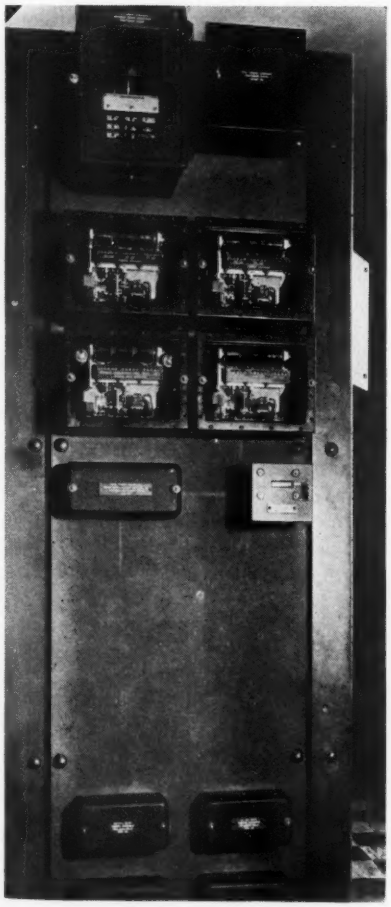


Fig. 4—Relay panel in control with flow totalizing equipment.

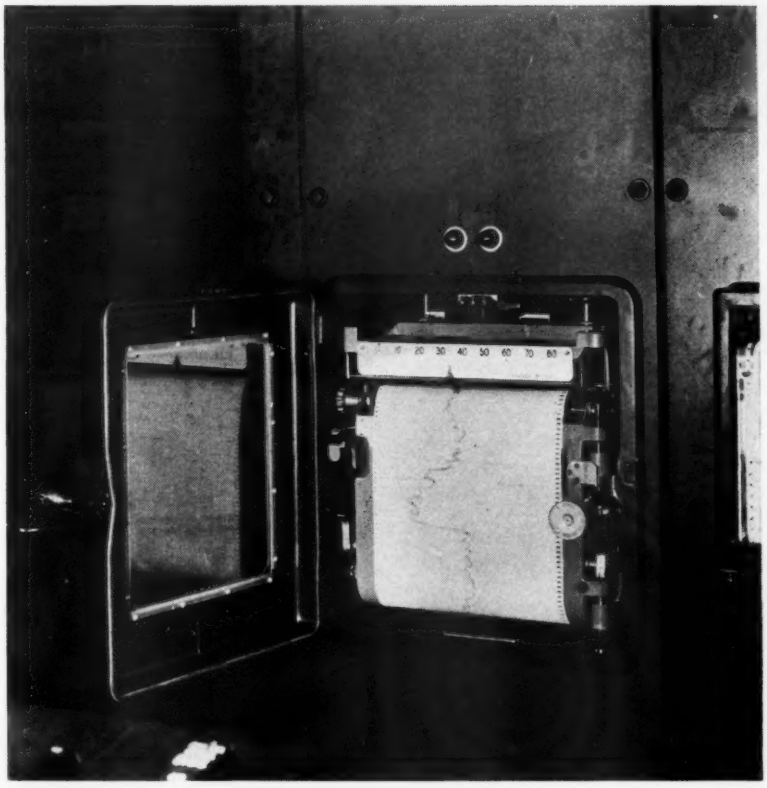


Fig. 5—Instrument panel in control room with station total flow indicator and recorder.

The initial flow meter installation comprised eight meters, one at each of the six main and two service units, Fig. 3. The seventh main unit was equipped with a flow meter when installed. The flow meters selected employ a rather unique principle, their design being based on the fact that the centrifugal force exerted by a flyball system driven by a motor integrator has the same relation of the rate of rotation that the differential piezometer pressure has to the rate of flow, thus leaving a direct proportional relation between flow and integrator speed. A counter geared to the integrator shows revolutions in terms of flow. Impulses for remote discharge indication and totalizing are obtained from an interrupter mounted on the counter shaft.

The remote totalizing apparatus is located on a panel of the relay board in the control room, Fig. 4. While three of the four totalizing relays serve as unit discharge totalizers for a group of three turbines each, one relay is used as master totalizer for the entire station, giving the sum total of the three unit totalizing relays. The station-total discharge counter is mounted below the totalizing relays on the same panel. Individual unit discharges can be determined from readings of the individual counters of the unit totalizing relays. A station total discharge graphic recorder and indicator combined in one instrument is installed on the instrument panel located opposite the totalizing relay panel, Fig. 5. The pen and indicator of this recorder are actuated by an integrating device totalizing flow every two minutes. At the expiration of each two minute interval positioning takes place corresponding to the average rate of station discharge during that interval.

The overall absolute accuracy of the input metering installation is of the same magnitude as that of the calibration method employed, possibly ± 1.00 per cent. The relative precision or consistency of the individual flow meters is appreciably higher being well within ± 0.25 per cent. The compensating effect of the individual flow meter errors

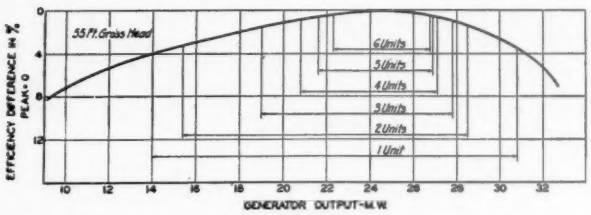


Fig 6—Typical loading schedule for Safe Harbor main units

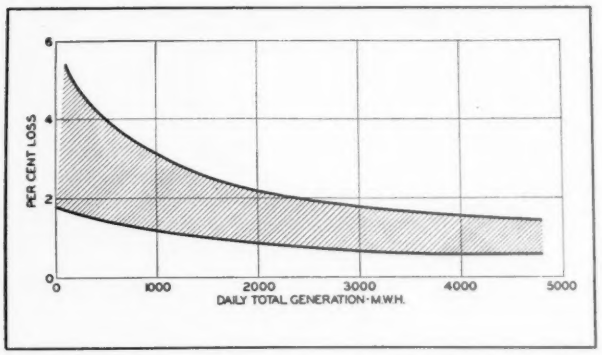


Fig. 8—Magnitude of losses due to all causes of inefficient operation.

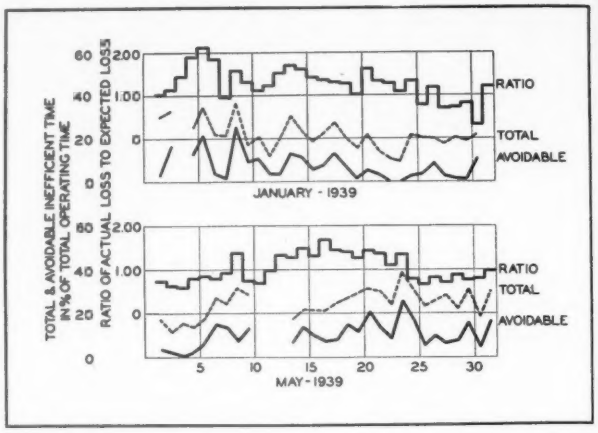


Fig. 7—Inefficient operating time and ratio of actual to expected loss.

tends to increase the relative precision of the entire installation; hence, its precision may vary between ± 0.25 and ± 0.1 per cent.

III. Investigations to Improve Operating Efficiency at Safe Harbor

The various investigations carried out in 1939 and 1940 may be divided into two parts: Those concerning individual unit efficiencies and those dealing with station operating efficiency as it affects the routine of the operators. Since we are here particularly concerned with the latter, it may suffice to say with respect to the former, that the type of flow meter selected permitted the carrying out of short duration efficiency tests on each unit as a routine making it possible to investigate in detail the efficiency characteristics over the entire range of operating heads. This study was particularly desirable as these turbines are of the Kaplan type requiring an adjustment of the cam controlling the gate-blade relationship for the various operating heads, the operators being instructed to change to a new cam setting after the actual head deviates from that for the cam setting by more than 1 ft. While these compensating devices on all units were originally designed and calibrated based on a minimum of information due to costly testing procedures, the flow meters available made it possible to check and recalibrate these compensating devices with a large amount of detailed information obtained with a minimum of effort. The results of the tests reflected favorably on the efficiency of the individual units and thus indirectly upon the operating efficiency of the station as a whole.

To appreciate the investigation regarding operating performance, it may be well to discuss first the typical loading schedule of the units, Fig. 6. From this ideal schedule valued for a gross head of 55 ft. and similar to that for any head condition, it is apparent that the band of permissible load variation of each unit decreases with increasing number of units on the line. With the seventh main unit placed in operation, this schedule is now the same in principle except that the permissible load variation of individual units with all seven main units operating is somewhat narrower than that in force when only six units were available. Under capacity requirements beyond the most efficient station operating range, all individual unit loadings are increased by equal amounts up to the point of maximum capacity.

The ideal loading schedule is not affected by generating power at two different frequencies as under normal operating conditions the 60-cycle and 25-cycle systems are tied together through a frequency converter with power flowing in either direction depending upon load requirements of the individual systems or available river flow. There is, however, a difference of sufficient magnitude in efficiency between individual units or group of units to warrant preferential operation. At the same time, the preferred order is subject to some variation based on the demands of 60-cycle and 25-cycle power to keep the over-all losses at a minimum including those sustained in converter operation.

Under normal operating conditions, the station service system is tied in with the main bus through the station service transformers. At times of low river flow only one service unit is operating with blocked governor at the point of best efficiency feeding power not required for station service into the main 60-cycle system. With excess water available, both service units operate at equal capacities so as to satisfy all station service requirements and feeding all possible excess power into the main 60-cycle system up to the maximum capacity of the station service transformer bank.

In view of the above, the determination of avoidable losses due to inefficient operation dealt primarily with the deviation of actual operation from the ideal requiring the running of the proper number of units for given load in accordance with the preferred order and equal load division between all main units on the line. To obtain the basic data for this analysis the operators were required to read the individual unit discharges and the station draft every hour on the hour together with the watthour meters as well as the forebay and tailwater indications. Comparing the actual operating losses based on input and output with the predetermined expected losses based on maximum unit efficiencies re-

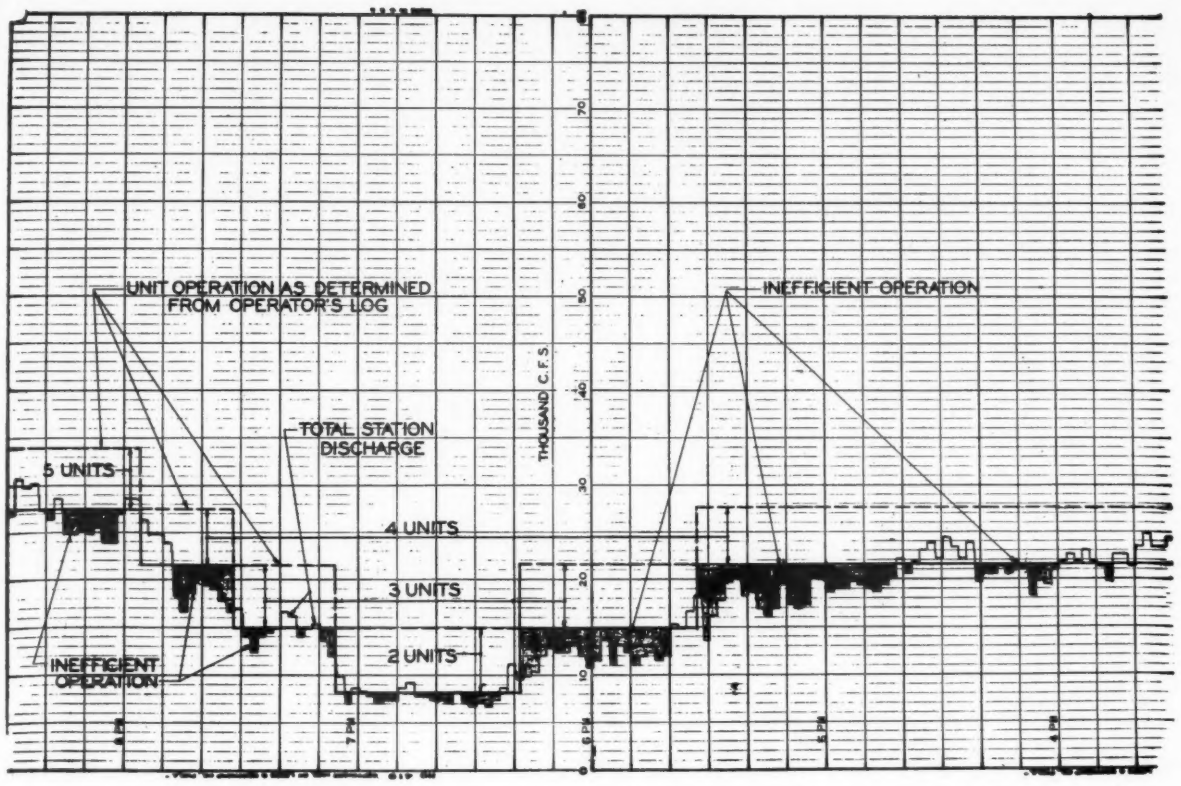


Fig. 9—Analysis of station total discharge recorder chart. In this instance the shaded areas of inefficient operation are due to operating with too many units on the line.

sults in a measure of the avoidable inefficient operation was obtained for any given day. The data thus obtained for an entire year were plotted as shown on Fig. 7, illustrating the results for January and May, 1939.

A comparison between these two months is interesting as it demonstrates already some improvement in operation. While, during the first month of flow meter operation, that is, January, 1939, the ratio of actual loss in generation to the expected loss was greater than unity on all but eight days, this ratio did not exceed unity during 18 days the following May. Since the runoff conditions during January and May were comparable and similar loading and operating conditions were prevalent, it must be concluded that the availability of an input yardstick had a decided stimulating effect on the operators. However, the fact should not be lost sight of that a great deal of time was spent by the operating personnel on each shift in keeping track of unit loadings, total station output and head conditions to determine at just what time it would be advantageous to put a unit on or off the line.

The daily avoidable losses due to inefficient operation were consolidated as shown in Fig. 8 representing the results for a whole year. As there were innumerable points, these are not shown individually. It is important to note, however, that there was no concentration at any particular location but the individual losses plotted were well scattered and equally distributed over the shaded portion of the diagram. From the shape of the shaded area, it is apparent that the percentage loss due to inefficient operation is increasing with decreasing station daily output. This is not surprising as during the low flow portion of the year relatively more pronounced load variations must be dealt with so that with decreasing runoff the frequency with which units are to be placed on or off the line is rapidly increasing if the ideal loading schedule for best efficiency is adhered to.

The shaded portion of the diagram, Fig. 8, could also be used as a basis for estimating the avoidable loss in generation. Assuming for instance that the operating performance could be improved to be at all times equal to the best found in course of these investigations, that is, along the lower boundary of the shaded area, the average gain in daily generation would vary between 1.5 and 0.5 per cent, that is, half the shaded area, resulting in a yearly gain in generation of more than 4,000,000 kwhr or 4,500,000 kwhr for the average low flow period and the six or seven main unit installation, respectively. However, as generation even at its best was far from ideal, substantial additional gains could be expected provided proper measures could be found to assist the operators in reaching further perfection in operating performance.

Obviously, not only the knowledge as to the magnitude of inefficient operation was of importance, but the cause and time interval during which the loss is sustained. For this reason, the charts from the total station discharge recorder were analyzed in the light of the operator's log. In plotting the permissible discharges for the number of units as of units in accordance with the prevailing head conditions on the plant and in line with the ideal loading schedule, Fig. 6, the beginning and end of each operating period within a given range corresponding to any number of units, was readily determinable from the chart, Fig. 9. The comparison between the limiting discharges for the number of units as determined from the operator's log pro-

vided the basis for the evaluation of the duration of inefficient operation. These data are also shown on Fig. 7 where the total and avoidable inefficient operating time is given in per cent of total operating time.

While some avoidable losses were traced to delays in trash removal from the intake screens, others could be attributed to unequal loading of units on the line. Both of these losses are relatively simple to eliminate. With a close continuous check on unit operating efficiencies available from the hourly input and output readings, any unusual drop in unit efficiency is immediately investigated. One of the first duties is to check on the screen losses independently and if these are found to be excessive the intake screens of the units affected are cleaned. As to the loss due to unequal loading of units, it was found advisable to check all governors and make their speed droop characteristics identical. This investigation is now under way and when completed should be materially helpful to reduce the tendency of drifting apart of units once equally loaded by the operators. However, by far the major portion of the avoidable losses were found to be due to improper scheduling. Based on past experience, it was realized that these losses could not be reduced anywhere near to a negligible amount without some means of direct indication when the plant was operating either efficiently or inefficiently. At the same time, it was essential that a scheme be adopted which would relieve the operators from the already burdensome activities responsible for some minor improvement to reduce inefficient operation from this source.

IV. Load Limit Indicating Apparatus at Safe Harbor

In course of analyzing the charts of the total station discharge recorder, particularly when plotting the discharge ranges for any given number of units on the line, it was discovered that these ranges were, for all practical purposes, independent of the head on the station if the ideal loading schedule valued for each head is adhered to. Thus the discharge, with one unit operating within the permissible load range varies between 4000 and 8200 cfs irrespective of the head. Likewise, the discharge ranges with any given number of units operating are also constant as shown in Table I. These discharge limits are calculated on the assumption that one service unit is constantly operating at the point of best efficiency.

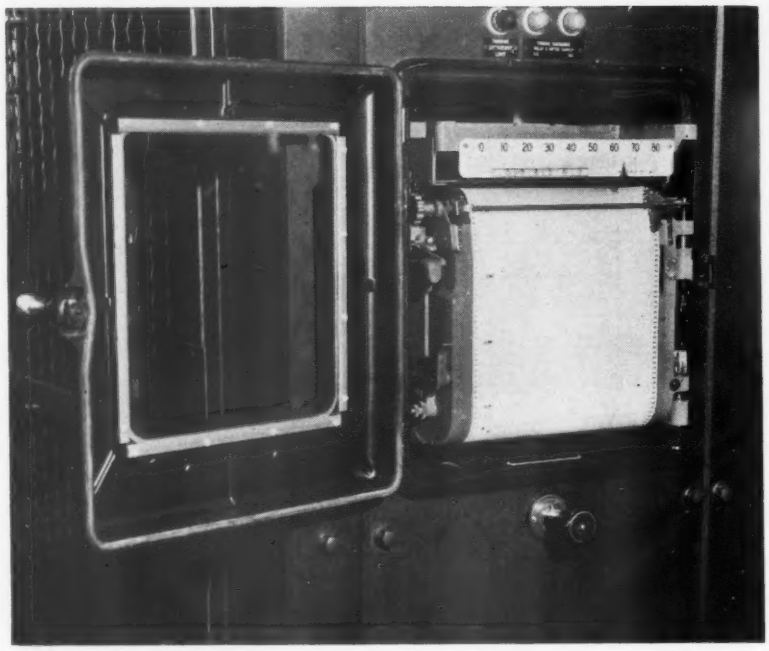


Fig. 10—Station total discharge indicating and recording instrument provided with unit discharge scale for most efficient operation; second pen element on the right of the chart plotting inefficient operating time. Warning lamp above recorder to signal inefficient operation; control switch below recorder for alarm setting in accordance with the number of units on the line and permissible station discharge. (Photograph taken when units were operating at maximum capacity.)

TABLE I. DISCHARGE LIMITS FOR UNIT OPERATION ACCORDING TO IDEAL LOADING SCHEDULE

Discharge Range No.	*Discharge-Range cfs*	*Number of Main Units Operating*
1	0- 4,000	0
2	4,000- 8,200	1
3	8,200-14,900	2
4	14,900-21,400	3
5	21,400-27,500	4
6	27,500-33,900	5
7	33,900-40,800	6
8	40,800-48,000	7

It is interesting to note that whereas the discharge ranges are constant the corresponding power output is varying with the head. In view of this it was obvious that an operating control for Safe Harbor could be based more advantageously upon the constant discharge limits, rather than on the varying power output. As a first step, the scope of the total station discharge indicator was enlarged by adding a unit discharge scale, Fig. 10. With the aid of this scale, the operators could observe when the loading on the station had reached a point to warrant the running of an additional main unit or to take one unit off the line. However, after some experience with this method of operation, a closer supervision of the discharge ranges was found to be essential, leading to the installation of an automatic alarm giving the operators warning when a limit has been reached. This alarm device, as installed, consists of two warning lights, one located on the operator's desk and the other on the instrument board above the station total discharge recorder.

These warning lights are lit automatically through a contact making cam arrangement built into the total station discharge recorder. For each load range between two station discharge limits, Table I, there is available one contact making cam assembly independently adjustable as to the part of the total discharge range it will control. A control switch was also provided with one position for each discharging range, that is, number of units to be operated, connected so as to keep the lights extinguished when set for the number of units to be in operation for best efficiency as long as the discharge is within the corresponding range. As soon as the discharge crosses the lower or upper limit of this range the warning lamps are lit from the contact assembly of the adjacent range and remain lit until either the switch has been reset to the number of

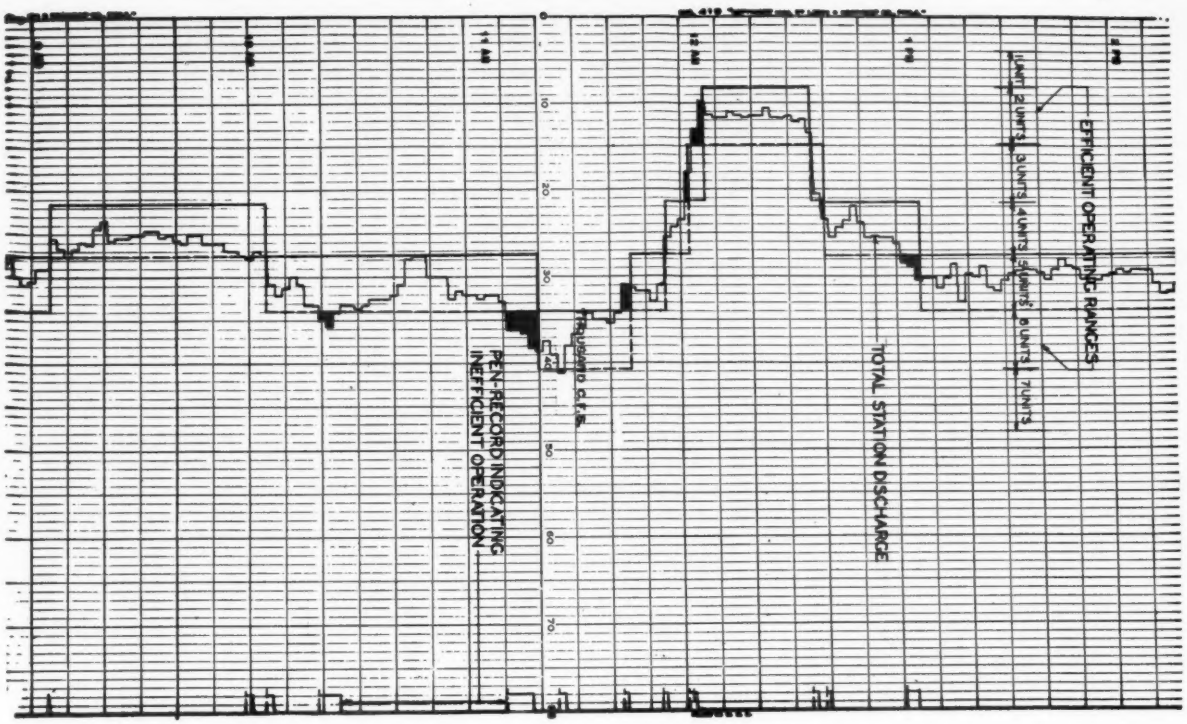


Fig. 11—Station total discharge recorder chart with pen record of inefficient operation. Note the small shaded areas of inefficient operation and showing practically ideal operation in contrast to that shown on Fig. 9.

units corresponding to this new discharge range or the discharge returns within the old range through total station load adjustment. Hence, with the control switch set correctly, that is, in accordance with the number of units in operation for best efficiency, the illumination of the warning lights will indicate inefficient operation.

To keep a definite record of inefficient operating intervals, the station total discharge recorder was also equipped with an additional pen element operating simultaneously and in parallel with the load limit lights, Fig. 10. This provision also enables the operators to ascertain the duration of the period of inefficient operation prior to noticing the warning lamps being lit. As soon as the warning has been noticed, the operator notifies the Load Dispatcher who, in turn, must take the responsibility in deciding whether or not a unit is to be shut down or placed on the line, whatever the case may be. At the same time, this indisputable record of station operation, Fig. 11, is of great value to the efficiency engineer to check on actual operating performance.

Since this apparatus has been placed in service, inefficient operation has been reduced to a minimum and it is estimated that the total average yearly gain in output due to all causes already obtained is in excess of 5,000,000 kwhr.

V. Various Types of Operating Efficiency Improving Apparatus

As the total gains accomplished at Safe Harbor are of considerable magnitude, it is believed that the losses due to inefficient operation now prevailing on hydro stations all over the country may run well above a hundred million of kwhr per year. Despite the magnitude of this loss, it is thought to be a conservative statement particularly in view of the fact that the appreciable losses previously sustained at Safe Harbor were prevailing with units of the Kaplan type of flat efficiency characteristics over a wide range of load. With other types of hydraulic prime movers installed, such as Francis or fixed blade propeller turbines, close supervision is thought to be even more essential because the efficiency curves of these turbines are more peaked causing losses under comparable operating procedures far in excess of those actually determined with Kaplan units.

The total annual monetary loss for the country is obviously difficult to estimate as each hydro electric development has its own economic characteristics. While for some plants the gain due to better hydro economy will be only in energy, others may also show a capacity increase depending upon whether or not the plant is a typical run-of-river development or a plant with major or minor storage facilities, respectively. However, in the light of actual experience gained at Safe Harbor, it is reasonable to assume that if an installation of this type of operating efficiency improving apparatus was justified with Kaplan units and based exclusively on steam energy replacement costs, some kind of operating guide will prove beneficial at many other plants.

Considering facilities already available as well as type of units, local conditions and loading schedules, the problem must be solved individually for each station. A few of the possible solutions may be discussed in the following. The various types of operating controls may be divided into three groups of apparatus: those based on electric output, those based on hydraulic input and those using a combination of both.

For the first group of apparatus the loads carried by individual units may be

totalized by thermal converters or torque balance transmitters. At different and predetermined values of total load carried by the plant, warning may be given either visible or audible or both by means of a contact making cam assembly similar to that described above for the Safe Harbor station discharge to indicate when a unit should be placed on or off the line depending upon rising or falling demand, respectively. With appreciable variations in head, it may be necessary to use an intermediate wheatstone bridge type of net head corrector because the permissible load ranges based on output may not be independent of head. This net head corrector would position a second slide wire in order to properly modify either the position of the alarm contacts or the totalized indication of station load used for the alarm requirements. Thus, the apparatus takes account of station load and variations in head as applied to the load limit alarm mechanisms.

The adjustment due to variations in head may be either manually or automatically controlled. If automatically, it would be advantageous to use slide wires actuated by head water and tailwater gages producing an electric potential proportional to the differential water level. In case the correction required is not directly proportional to head and since a change in unit efficiency due to variations in head may be superimposed, the correcting slide-wire in the net head corrector may have to be tapered. Whether or not a graphic feature for this type of operating efficiency controlling apparatus based on output would be of advantage or simply the alarm mechanism is subject to each individual solution but obviously discretion must be used as to the desirability of recording actual watts or corrected watts or both.

The second group of operating efficiency controlling apparatus is based primarily on hydraulic input provided with or without adjustment for head. The apparatus installed at Safe Harbor is perhaps a rare case in not requiring any head adjustment. Piezometers, if required, can readily be installed in any turbine with a scroll case as the piping does not have to be embedded all the way to the piezometer taps but only in their immediate vicinity to prevent local disturbance.

In many cases it may not even be necessary to measure the input but a contact making device placed at each unit and operated by the Servo motor pistons of the turbine gate mechanisms may prove entirely adequate. An installation of this kind has been placed in service some time ago at the Holtwood plant of the Pennsylvania Water & Power Company located downstream of Safe Harbor. Using appreciably less flow at maximum station output for the installed ten Francis units with a total rated capacity of 150,000 hp, the relatively small incremental load from each additional unit placed on the line at Holtwood can be readily absorbed by the system. During low flow, the object is, therefore, to place units on the line in a preferred order and open the gates to a point of maximum efficiency. As the highest range on the efficiency curve of each unit is known in terms of gate opening, a contact making device operated by a Servo motor piston and lighting a warning lamp was installed at each unit indicating to the operator when the point of best efficiency has been reached. A small contact band corresponding to a few per cent in gate opening permits the load to vary within these limits without extinguishing the light. Although there is a relatively minor influence due to variations in head, nevertheless, some experiments are now being carried out regarding possible head adjustment for this alarm device.

Representatives of the third group operating efficiency improving devices are unit and station efficiency indicating and recording apparatus giving the operators and the efficiency engineers a direct measure and record of actual operating performance. Apparatus of this type may also be equipped with alarm devices. Continuous efficiency indication and recording obviously involves the relating of kilowatts produced, discharge and head. These quantities making up the efficiency equation can be translated into electrical potential and electrically correlated so as to provide the efficiency record desired. As discussed above, a potential in proportion to unit or plant output may be obtained either by means of thermal converters or torque balance transmitters. A potential proportional to unit or plant discharge may be secured by means of an impulse mechanism positioning a slide wire, the impulses being obtained either from a flow meter, or through a totalizing apparatus, respectively. The two potentials proportional to electric output and hydraulic input are fed to an intermediate controller equipped with a retransmitting slide wire producing a potential corresponding to the ratio of kilowatts divided by flow of water in cfs. Standard slide wire positioning devices are also advantageous in securing a potential related to head, the slide wires being operated by headwater and tailwater gages. An indicator and graphic recorder combined in one instrument and of the potentiometer type of special construction only with regard to the electrical measuring circuit, will balance the potential corresponding to the ratio of input and output and the one relating to net head so as to perform automatically the efficiency equation. It is noteworthy that for installations of this kind no particular development work is necessary as the entire apparatus is in effect simply a combination of standard type instruments and readily obtainable.

VI. Conclusions

In the light of the investigations carried out at Safe Harbor regarding avoidable inefficient operation, the specific solution of this problem and the various types of apparatus which may be suitable at other plants, it is believed that the field of operating efficiency is not the exclusive responsibility of the operators but also that of the engineers by providing equipment making it possible for the station personnel to operate efficiently. One of the advantages of this general type of equipment is that the operators may give their individual attention to their varied normal operating duties without being preoccupied with station economy. The operators' attention to such matters is only required when automatic warning is given. At the same time, the investigations have shown that even with all efforts bent to avoid inefficient operation, the operators are limited in their accomplishment to a relatively small fraction of what may be obtained with proper apparatus available. Since the gains to be accomplished through elimination of avoidable inefficient operations are appreciable, the economic benefits may now prove more beneficial than ever to the over-all economy of utilities and the country as a whole.

REFERENCE LITERATURE

1. "Turbine Discharge Metering at the Safe Harbor Hydro Electric Development" by J. M. Mousson, Trans. American Society of Mechanical Engineers, July, 1941, Vol. 63, No. 5, pp. 369-379.

2. "Improved Type of Flow Meter" by I. A. Winter, Proc. American Society of Civil Engineers, Vol. 59, Part 1, 1933.

3. "Two Methods of Measuring Water to Hydraulic Turbines," Power, Vol. 77, March, 1933.

4. "Water Gauging for Low Head Units of High Capacity" by J. M. Mousson, Trans. American Society of Mechanical Engineers, Vol. 57, 1935.

Industrial Lighting—The Need of the Hour

By Frank R. Auchy

Philadelphia Electric Company, Philadelphia, Pa.

An address before the Eighth Annual Sales Conference, Edison Electric Institute, Chicago, March 31-April 3, 1941

WITH the passage of the Lease-Lend Bill by Congress, American industry assumed the dominating position in defense activities. It is faced with the immediate necessity of supplying, not only the normal peacetime needs of the country, but the staggering task of producing the military requirements of an unpredictable portion of the entire universe. The need? *Production*—Production of shirts and ships, shoes and shells, planes—munitions — tanks, guns — armaments — hats — coats and socks. Headlines and huddles beseech the quick need of production and more production, but above all *Time*. *Time* is of the essence, we are told, to insure a successful culmination of the defense program, so vital to the safety and well being of the nation. All this and unity too, complete *coordination* of government, industry and labor.

Not long ago, a Philadelphia news item read: "The employees of the Midvale Steel Company's huge plant, in a precedent-establishing vote, have decided to work seven days a week." In the same paper the National Association of Manufacturers announced—"The initiation of a series of Defense clinics in an effort to *re-arm* ahead of schedule." *Time* is, indeed, a most important factor. A phrase of John Cecil Rhodes aptly describes the situation—"There is so much to be done, and so little time in which to do it."

It is the purpose of this paper to stress the intrinsic value, or rather the indispensability, of modern lighting in this emergency, with particular emphasis on its relation to *Time*—time saved in production, protection against time lost through sabotage, and time lost through accidents.

That lighting is indispensable admits of no argument. Picture, if you can, a vast armament producing or machine tool plant, its batteries of humming lathes or milling machines illuminated by myriads of flickering candles, by the feeble flames of smoking oil lamps, or even by the glow of carbon filament lamps. Possibilities of mass production would be exceedingly remote under such archaic seeing conditions. Fortunately for the state of the nation such primitive methods are obsolete, for in recent years there has been a steadily growing acceptance of the principles of Better Light-Better Sight based on the science of seeing. Time will not permit a review of the innumerable factors contributing to this advancement. But mention should certainly be made of the painstaking experiments and the comprehensive studies of industrial processes by the various research committees of the I.E.S. These have resulted in the perfection of new standards and techniques for the satisfactory solutions of many lighting problems. In turn lamp and equipment manufacturers, notwithstanding the unfavorable economic conditions that prevailed, kept pace with the new developments of the laboratory and the research engineer. The effect is —an abundance of efficient lighting tools, scientifically designed to do a specific job.

This progress was noteworthy in view of the fact that during this period plant lighting has definitely lagged. To illustrate—in the period from 1933 to 1937, the total value of all lighting equipment sold was increased by 67.5 per cent, compared to an increase in industrial lighting of only 39 per cent.

Undeterred, however, they carried on, realizing full well that the ground work they laid would show surprising results as economic conditions improved. That these efforts were not in vain may be well appreciated by a comparison of the lighting tools in the kit of the illuminating engineer of today, with those available in 1916, the eve of our entry into the first World War. I quote from the N.E.L.A. salesman's handbook of that year: "One may choose today among lights of many kinds. There are at hand candles, oil lamps, open flame gas jets, upright and inverted mantle gas lamps, electric incandescent lamps of tungsten and carbon, electric arcs of half a dozen varieties, besides mercury-vapor tubes, acetylene lamps and so on." The same handbook also says—"Requirements for machine shop lighting call for intensities in the order of 2 to 7 foot candles. While my association with lighting began in 1920, there are undoubtedly many in this group who well remember that page.

In sharp contrast to the crude tools of that period, let's examine some of the streamlined equipment that Science and Industry has placed in the hands of the seeing specialist of today:

Under the heading of *General Lighting*, our modern tools where mounting heights are not excessively high, comprise the tried and true RLM Dome reflector, available with accessories of dust-tight glass covers, diffusing glass covers, or daylight blue cover plates, depending on the requirements of the application. Reflectors of prismatic glass are dependable tools in this field, as well as the Glassteel and Silver Bowl Diffusers, all designed to provide maximum control of light distribution.

Within more restricted mounting heights the RLM Fluorescent unit offers an ideal tool for many purposes and is being widely applied.

For higher mounting services, high bay and medium bay reflectors serve a specific purpose in projecting useful light down to the working plane. Designed to utilize incandescent or high pressure mercury vapor lamps or a combination of both, they provide efficient and satisfactory lighting tools. The difficulty of projecting fluorescent lighting any great distance, renders this type of equipment unsatisfactory in this field.

Bench work usually requires relatively high levels of light and freedom from projected heat or glare. To provide this, some form of localized lighting is essential. Functionalized fluorescent equipments are manufactured in many types and have been widely applied over the past year, although many applications exist where, due to the size of equipment, or qualities inherent in the lamp itself, fluorescent lighting is not the best solution. Other lighting tools are available, depending on the requirements of the seeing task, such as the RLM bowls, various types of industrial intensifiers, Reflector Spot lamps and tubular bulb reflector lamps.

Inspection operations have always been a problem for the lighting engineer, and each one must be individually analyzed. Again, the contributions of the I.E.S. research committees in solving many involved inspection problems must be highly commended. This has resulted in the design and manufacture of many specialized lighting tools, of which, the large area—low brightness types are an example. Fluorescent lighting equipment is available as well, in a wide range, and is adaptable to multitudes of inspection processes.

In the field of exterior lighting, whether the need be for protection, construction, loading or safety, there is an abundance of the correct lighting tools to apply—dome and angle type reflectors, floodlighting units, long range projectors, refractors of prismatic glass, utility spot lights, and projector lamps.

So—far from being caught napping, the National emergency finds the illuminating engineer well prepared, ready and willing to play a conspicuous part in helping industry go over the "Productive Top."

Effectiveness of Lighting Tools on Time, Production, Safety and Protection

Modern lighting in the hands of trained illuminating engineers, may well be described as vital tools in production.

What Methods Should We Use to Apply Them Best?

We should first—Identify the seeing task.

Second—Apply that seeing in terms of contrast, glare, and any factors entering into the seeing problem.

Third—Apply that fundamental information to determine quantity and quality of light required.

Fourth—Utilize to best advantage the proper equipment, based on the specifications obtained thereby—"The Right Light for the Right Place."

What are the Results in Terms of Time, Production, Safety and Protection?

The Science of Seeing indisputably proves that it takes *Time* to see. Craftsmen are only as efficient as their ability to see what they are doing. The scientific use of modern lighting will save *time* and eliminate bottlenecks by accomplishing greater *production* efficiencies—because it increases the speed and accuracy of vision. In other words—Production speed depends on seeing speed. Tests have proven that increases in production ranging from 10 to 35 per cent may be expected when modern lighting is substituted for poor lighting; a visual task requiring 55 seconds under 3 foot candles, can be accomplished in 35 seconds with 50 foot candles. *Time Saved*—Every machine, every process, every worker is retarded by obsolete lighting which handicaps seeing. Older eyes are replacing young eyes as the demand for man-power increases. Visual acuity definitely decreases with age, emphasizing the vital need of higher intensities in industry.

The quality of a product is likewise dependent on the ability of the employee to see easily and quickly. Rejects are a prolific cause of wasted *Time*. With today's emphasis on rigid tolerances, and precision machine work, accuracy is extremely essential. Exhaustive studies have demonstrated that proper illumination will materially reduce spoilage and waste, including *Time* lost in repairs and adjustments.

From a standpoint of safety—Statistics that have been compiled by the National Safety Council indicate that poor lighting directly causes 5 per cent of all industrial accidents, and is the contributing cause of 20 per cent. Removal of a contributory cause usually prevents an accident. Ignoring the dollar loss sustained by industry through accidents; the actual loss in production in man power and in wasted time spent in machine repairs is tremendous. Modern lighting promotes safety and stops accidents before they happen.

Protection against the menace of willful destruction is a present day problem of paramount importance. According to Arthur H. Crowl of the Federal Bureau of Investigation—"Every plant should be floodlighted to illuminate adequately every part. Our experiences with sabotage during the last war, of which the tragic "Black Tom" incident was one, indicates the immediate need of protective lighting in every plant engaged in defense work in order to deter intruders from entering and to make them clearly discernable if they do. Here again, the Lighting Engineer is well equipped with the proper weapons to wage an all-out war on the saboteur.

If I have appeared to dwell unnecessarily on light in terms of defense, it is for the reason that it has focused universal attention on the necessity of adequate lighting as a definite means of attaining it.

Thus, our path to higher levels of illumination is made easier for us, not only as an essential adjunct of defense production, but applying as effectively to all production. Obviously, some of the defense plants will discontinue operations when the program is completed, but others will be converted to the production of plow shares and other peacetime requisites necessary to rehabilitate a war torn world. The higher level of lighting that is essential to all these operations now, will, of necessity, continue to be equally essential in peace-time operations. Therefore we should not devote our exclusive efforts to those customers engaged in defense production—rather we should exert even more intensive pressure in selling adequate lighting to those plants engaged in producing the requirements of our normal existence. These plants will continue to operate after war preparation is over. The extent of our permanent load of the future will be largely governed by what we accomplish in these fields today.

What are the fundamentals of selling adequate industrial lighting?

It requires the coordinated effort of utility salesmen to promote the idea, of the lighting engineer in specifying sound lighting applications, and of the equipment salesmen and the contractor in selling and installing the actual job.

I would like to tell you how we in Philadelphia have been handling this problem, with relation to our normal industrial load, for several years past, and how we are adapting our plan for the sale of adequate industrial lighting under today's conditions, with particular reference to the permanent load I have just spoken of.

We have had quite a problem with industries engaged in defense, for the need of expanded productive facilities and buildings to house them has been sudden and swift. The plant engineer and his staff have been literally swamped with great masses of detail, of which lighting was only one. With time limitation an important factor, his first inclination was to purchase and install in the shortest possible time a standardized system of lighting that would require a minimum of time for maintenance and replacement, thus sacrificing, to a certain extent, good lighting to expediency. The accent, however, is on production, and he is fast coming to an appreciation of the fact that well-applied lighting is the best aid for obtaining it.

Here again it is the problem of the

industry to plan an aggressive course of action that will fully educate the customer on the *Need* of proper lighting, the necessity of carefully planning that lighting, and the lasting benefits which will accrue from its proper application.

If we take sufficient advantage of the opportunity that the defense program thus offers us, to effectively sell the idea that adequate lighting is a necessity applying to *all* industrial operations at *all* times, and *if,* in so doing, we accustom employees to the benefits of laboring under higher levels of illumination, then we will perpetuate the use of that lighting in peace-time. Thus we are creating, in effect, a cushion against the inevitable recession that follows.

To achieve these results we must, as salesmen of ideas, sell the customer on the idea that it is to his best interests to utilize the service that we offer on lighting.

The specifications that the lighting engineer prepares must be soundly engineered to be of continuous benefit to him over a reasonable stretch of years.

The facts must be adequately presented to form a clear and concise picture in the customer's mind of the economic and other advantages involved.

There must be established a schedule of progressive follow-up calls by utility, manufacturer, jobber and contractor. It must be realized that the timing of these calls is *all-important,* in order that they occur in proper sequency, and at proper intervals for maximum effectiveness.

Such a plan is equally necessary for both normal and defense promotional activities and must, of necessity, command the entire accord of these groups in order that complete adherence to the specifications be observed. Conflicting ideas, however sound, serve merely to confuse and the advantage of an undeviating story to the customer is obvious. We will always have with us, however, the misguided salesman who, fearing competition, will attempt to substitute for a soundly engineered specification, something just as good. The inevitable result is a dissatisfied customer, less profit for himself, and less revenue for the utility. As coordination of government, industry and labor is essential to the defense program, just so is coordination necessary to retain an unbroken front, in the promotion of adequate lighting to industry.

The attainability of such coordination may well be illustrated by the results achieved in Philadelphia.

Prior to about 1930, our most profitable market lay in the shutting down of isolated plants, and providing for increases and expansions of existing customers. With the point of relative saturation reached in the former, and the possibilities of the latter adversely affected by the depression, our continued existence as a sales organization necessitated the developing of new fields, which were to be found only in the intensive development of the greater use of our services by our customers. Lighting, among a host of other applications, was a most fertile field, the exploitation of which could be accomplished only by aggressively going after every sale, however small.

In 1932, therefore, our industrial sales department started to develop direct-by-mail cooperative campaigns for the purpose of promoting increased use of our services; lighting, air conditioning, heating, and others.

From a lowly start of four-page folders featuring a letter on the cover, our direct-by-mail campaigns have been stepped up over the years with a more dramatic approach. Art work, color and a continual variation in types of advertising pieces—broadsides, booklets—even visualizers—have effected a constant variety which, we feel, has been of direct benefit.

In this connection, it may be of interest to some of you that the Philadelphia Electric Company operates its own advertising department. With this situation, we are able to maintain a particularly close contact with those who prepare our material.

During this period there were built up, within the Electrical Association of Philadelphia, strong closely-knit industry groups, including one known as the Lighting Equipment Manufacturers Group comprising some 35 members. The prime function of the Lighting Group was to promote, through educational and other methods, the sale of adequate lighting in the Philadelphia territory and to keep the consumer advised on new developments and applications of lighting.

Once a month, this group met with key lighting men of the Philadelphia Electric Company and of the Electrical Association of Phila., to discuss problems of mutual interest, affecting the consumer, the manufacturer, the utility, the wholesaler, contractor and kindred subjects. As the result, a splendid cooperative spirit had already been developed within the lighting industry of Philadelphia.

It was to this group that we submitted for approval in 1936 our matured plans for a cooperative industry lighting campaign, the first of which was conducted in the Fall of 1937. It included utility manufacturers and their respective jobber organizations. Similar campaigns have been conducted each year since, and have been so successful that the contractors requested to be, and were included in the 1940 campaign. The actual details and methods of procedure follow:

The activity generally starts about September 15, preceded by a get-together dinner of manufacturers, jobber salesmen, utility salesmen, and, in 1940, electrical contractors. Here the plan of procedure is outlined. Leads are accepted up to December 1, and sales must be closed by December 15, the end of the allotted campaign period. Results are then computed, and prizes are awarded at a closing meeting. A wood mounted silver plaque is bestowed, with suitable ceremony, on the jobbing house whose record of performance shows the highest average rating per man participating.

Following the inaugural dinner in September, our industrial lighting promotion group, of which I am one, select from a systematically maintained file of prospects, a list of customers who are to be contacted during the course of the activity. The first of two promotional broadsides, containing the names and pictures of local equipment applications of the participating manufacturers, are mailed to the customer, followed within a week by a call from the utility salesman. Good leads thus developed, and the specifications subsequently prepared, are made available to all of the participating manufacturers and to the jobbers to which they assign the case. In the interval, the second promotional broadside has reached the customer, keeping alive his interest in good lighting and preparing the way for the next progressive step. On completion of the specifications, arrangements are made for customer contact by both utility and jobber salesman assigned, to present the specifications and to close the job.

While the leads developed in the campaign are generally turned over to all participating manufacturers, steps are taken to protect prospects on whom a

participant was already working when the campaign started. Immediately before the opening of the campaign period, we are provided with a list of such cases, which are then classified as "confidential leads," and are not turned over to the group as a whole, except when duplicate reports are made, in which case it is no longer confidential.

To increase the incentive of those participating, cash prizes are awarded to both utility and jobber salesmen. The amounts vary, consistent with the wattage sold, and the lighting intensities obtained. To be eligible for prizes, all ininstallations have to conform to definite requirements as follows:

1st—Minimum requirements in lumens per sq ft installed.
2nd—New cooperative equipment only.
3rd—A minimum area.
4th—Actual cooperation between jobber, contractor and utility had to be shown.

The plan is designed to exert continual promotional pressure, to fully acquaint the customer with the advantages to be derived from good lighting.

The specifications contain factual data pertaining to maintenance, paint, adequate wiring, power factor correction, and a comprehensive rating chart that enables the customer himself to make an intelligent selection of lighting fixtures.

As an additional promotional tool, a publication which we call "Light Flash" is mailed to a representative list of customers each month. Outstanding local lighting installations are featured together with interesting descriptive articles. This has tended to further public acceptance of adequate lighting, and has contributed materially towards keeping alive, throughout the year, the cooperative spirit fostered by our plan.

You will be interested to learn of the more concrete results that have been obtained as the result of this cooperative idea—"The Philadelphia Plan" in terms of kilowatts sold.

In 1937 seven manufacturers of lighting equipment participated, with a total of 11 jobber organizations. After the birth pains had subsided, we found that:

> Sixty-eight utility and jobber salesmen had cooperated in selling 153 customers a total of 4840 kw of which 40 per cent conformed to campaign requirements.

The value of the participating manufacturers' equipment sold was $172,500. In the three years immediately following, the plan continued to function smoothly and with constantly increasing results. With the launching of the fluorescent light source, the proper application and development of which was of paramount importance to customer and the industry alike, ample opportunity was afforded to test the effectiveness of the cooperative groundwork that had thus far been established.

At the close of the 1940 activity we found, when the smoke had cleared away on the final day, that—

> One hundred thirty-nine contractors—utility—jobber salesmen had cooperated in selling 16,268 kw of which 56 per cent conformed to campaign requirements in new equipment valued at $1,326,260 to 887 customers who are thoroughly sold on the value of
>
> THE RIGHT LIGHT FOR THE RIGHT PLACE

Surely—the Electrical Industry has the tools, possesses the ability, the knowledge and the foresight to apply them.

THE NEED OF THE HOUR—COORDINATION

Wood Pole Specifications Standards Adopted by ASA

SIX tentative standards covering specifications for wood poles have been formally adopted as American Standards, the ASA reports this month. These standards, of especial interest to the builders and operators of overhead electric, power and communication lines, were prepared under the sponsorship of the ASA Telephone Group which is made up of the Bell Telephone System and the U. S. Independent Telephone Association. They represent a consistent system of standards for the six major pole timbers of the United States —northern white cedar poles, western red cedar poles, chestnut poles, southern pine poles, lodgepole pine poles, and Douglas fir poles.

The wood pole standards have been in use for several years as tentative standards and have already been universally recognized as a satisfactory basis for the selection of poles. They establish practical limits that can be applied economically in the production of poles for general use, but they are also flexible enough to cover the purchase of poles of high quality for special purposes. These standards are so drawn as to give the maximum economy of the entire usable cut.

Included in the standard specifications are material requirements for shape and straightness of grain, limit defects such as knots, checks, insect damage and decay, and the minimum quality of acceptable poles is defined. Departures from straightness are held within practical limits for ordinary use. Decay and the presence of wood-rotting fungi are generally prohibited. Definite limitations are set, and fire-killed poles are acceptable only by special arrangement between producer and purchaser.

The standard dimensions now included with the specifications in one standard for each type of pole were based on recommended fiber stresses contained in the American Standard for Ultimate Fiber Stresses of Wood Poles. These standard dimensions have all been prepared according to the same principles for all types of poles. The sizes at six feet from the butt in all six standards have been so fixed with respect to ground-line resisting moments, that, for any given class and length of pole, all six species are equal in strength. In calculating these six-feet-from-butt sizes, distance from the butt to the ground line for any given pole was assumed, by definition, to be as shown in the column in the tables headed "Ground Line Distance from Butt." The equality-in-strength principle holds good, however, for any reasonable depth of set required.

The committee responsible for these specifications is made up of representatives of 25 national organizations. Copies of the new edition of these standards may be ordered from the American Standards Association at 20c. a copy. They are listed below:

American Standard Specifications and Dimensions for

Northern White Cedar Poles—05.1-1941.
Western Red Cedar Poles—05.2-1941.
Chestnut Poles—05.3-1941.
Southern Pine Poles—05.4-1941.
Lodgepole Pine Poles—05.5-1941.
Douglas Fir Poles—05.6-1941.

Modern Kitchen Bureau Announces Fall Promotions

AN action, three-color window display, an electric range radio program recording, and a direct tie-in with the national electric range advertising in women's magazines, are offered by The Modern Kitchen Bureau in its fall electric range campaign. Entitled "Switchover Month," the campaign is the most complete yet offered by the Bureau, and is expected to prove highly effective.

The window display features enlarged color photographs from the national advertising. The electric light and the surface unit of the electric range shown in the display flash on and off, illustrating the advertising theme of the campaign, "The Switch Is ON—Cooking's Going Electric!" which is in itself a direct link with the national advertising and its slogan, "The Switch Is to Switches Again"—one which enables every utility and dealer using this campaign to employ the national advertising to build up their own prospect lists. The advertising, now appearing in five leading women's magazines, will continue each month through December.

Sixteen one-minute announcements, dramatically selling electric cooking in song, verse and dialogue, make up the first electric range radio program recording ever offered by The Modern Kitchen Bureau. Time is allowed for local terms, individual brand copy and sponsor's signature. The record is expected to be just as successful as was the electric water heater program recording offered by MKB last spring—used by more than 100 utilities in 35 states!

With the action window display and the radio recording, the Bureau is offering a complete assortment of promotional materials to round off the campaign. Each carries the theme of "The Switch Is ON—Cooking's Going Electric!"

A three-color counter display card, two three-color direct mail pieces and four newspaper advertisements will help promote "Switchover Month." Suggested designs for billboards, truck posters and car cards are also offered, and can be completed locally at small expense. Window and letterhead stickers complete the campaign.

Water Heater Programs

"The Second Half of the Biggest Water Heater Year Yet!" is the theme of MKB's fall water heater program, and the football idea is carried out through all phases of the campaign—a timely, forceful theme that's stressed for sales!

A NEW radio program recording, prepared in answer to hundreds of requests, is ready to put the sales punch of radio's top-flight programs to work, increasing sales and load. Complete with music, drama and action, special story plots and song, the recording features Ford Bond, leading network announcer, and "Honey Chile" of Bob Hope fame.

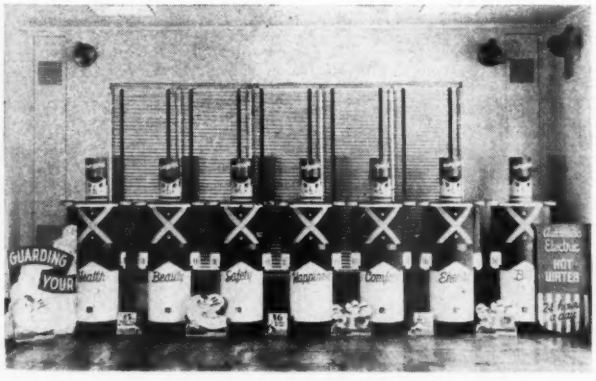
A window and floor display cut-out features Donald Duck and his nephews, popular Hollywood and Modern Kitchen Bureau characters, wearing football uniforms in full color. Four counter cards bring out the cleanliness, convenience, safety and comfort of electric water heating. Mailing pieces, newspaper advertisements, and envelope enclosures are also included.

The second half of MKB's water heater contests, for outstanding window displays and floor demonstrations, will offer a total of $500 in cash prizes. Utility men are particularly interested in these contests, for the ingenious displays that win cash prizes for their designers will also stimulate sales, which will assist the company's entry in the Bureau's contest for the best electric water heater performance by an operating utility during the year.

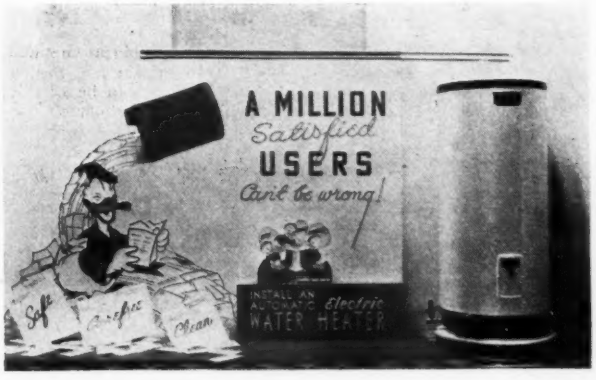
Full information on both these programs is contained in The Modern Kitchen Bureau's Fall Plan Books, which will be sent to any utility executive upon request. Address the Bureau at 420 Lexington Ave., New York, N. Y.

New Plan Committee Chairmen

W. A. Grove, advertising manager, Edison General Electric Appliance Company, Chicago, Ill., has been elected chairman of the Plan Committee of The Modern Kitchen Bureau for 1941 and 1942. Roger Bolin, manager, Merchandise Advertising and Sales Promotion, Westinghouse Electric & Manufacturing Company, Mansfield, Ohio, will be the vice-chairman of this committee for the same period.



D. N. Merrell, Manager of Residential Sales, The Ohio Power Company, Tiffin, Ohio, received first prize in The Modern Kitchen Bureau's spring of 1941 Electric Water Heater Floor Demonstration Contest with this display.



C. M. Griffin, Display Manager, Ohio Edison Company, Youngstown, Ohio, won first prize in the bureau's spring of 1941 Electric Water Heater Window Display Contest, for the second time in succession, with this display.

Salesmen are Stymied when Conduits are Crowded...
Promote Re-Wiring NOW—
and Have Capacity Ready for Future Needs!

Re-wiring with small diameter wire means increased markets for utility industrial and commercial services. Here are new promotional tools now ready to help you cash in on your wiring story. Dramatic—factual—they'll give your promotion the showmanship it needs for real sales results!

●

This Kit Makes Your Story Clear Even to Non-Technical Prospects

Kit contains samples of conduit and 18 sample combinations of small diameter wire, which clearly demonstrate how capacity of existing conduits can be doubled and tripled. Prospects see different combinations pass through the conduit, get dramatic proof of extra capacity.

Then they hear how thin-wall insulation wire is drawn into existing conduit, how they can have the modern building, that means more and satisfied tenants, without expensive, extensive alterations.

Kit size, 8″ x 5″ x 1¾″. Price, $1.75.

Dramatized Presentation on Commercial Re-Wiring

This presentation, illustrated by Kodachrome lantern slides, can be adapted to every commercial and industrial group concerned with re-wiring—shows your audience why small diameter re-wiring deserves active support by the electrical industry, serious consideration by building owners.

Slides and suggested talks are furnished for following audiences: 1. Contractors. 2. Inspectors. 3. General — building managers and engineers, architects, electrical and utility men.

Price, $17.50. Set of slides and accompanying talks.

Dramatized Presentation on Home Wiring

These illustrated lantern slide talks in Kodachrome will appeal to every group interested in promotion and use of residential wiring. Local facts and pictures can be readily inserted. Talks cover cost of service, outlet location, efficient layouts, wiring promotion.

Separate talks furnished for following audiences: 1. Utility employees. 2. Contractors, inspectors, builders. 3. Architects, engineers. 4. Contractors. 5. Consumers.

Price, $35.00. Set of slides and accompanying talks.

Handbook of Facts on Small Diameter Re-Wiring

This handbook is packed with data on new building wires, their capacity, types of service entrances, feeder and branch circuits and their arrangements. Covers use of bare neutral conductors, multiple conductors for high capacity. Tables show sizes of building wires, number of wires in conduit, voltage loss in circuit, and other useful information.

Entitled "Re-wiring for Commercial and Industrial Buildings," it brings utility salesmen, engineers and contractors up-to-date on new re-wiring methods.

Price, single copies, 25c. Quantity prices on application.

Order from

Edison Electric Institute

420 Lexington Avenue New York City

Joint Subcommittee on Development and Research Meeting

THE Joint Subcommittee on Development and Research met with its project committees on June 12 in New York, with Mr. A. E. Silver presiding. The various project committees presented progress reports covering the work of the past six months. In addition, four technical reports were presented.

Project committee 1A—noise induction, submitted a technical report entitled "Susceptiveness of Subscriber Station Sets." Information on the inductive susceptiveness of subscriber station apparatus is frequently required in connection with noise induction problems in the exchange telephone plant. Data of this character available to the field heretofore have been limited chiefly to sets employing No. 337 transmitters and No. 144 receivers. The large number of No. 557 receivers now in the plant and the introduction of newer types of instruments, induction coils and ringers have emphasized the need for more comprehensive information on this subject. The results of an investigation undertaken to meet this need are summarized in this report. The basic data are presented in a series of curves of single-frequency ratios of receiver current to voltage to ground on the various station sets. For convenience in estimating receiver noise due to station set unbalances from analyses of noise to ground in specific noise problems, values of receiver noise (in db) per volt to ground have been tabulated for a number of sets for harmonic frequencies of 60 cycles in the range from 180 to 2700 cycles. In addition, a comparison of the susceptiveness of a number of the more common station set arrangements is given for composite-frequency noise to ground. The receiver noise values given for the No. 557 and No. HA1 receivers have been adjusted to correlate with the 144-type receiver noise transmission impairment scale.

Project committee 1B—noise evaluation, presented a technical report entitled "Frequency Weighting for Message Circuit Noise." This was a revision of a report of the same title presented at the December meeting (EEI Bulletin January 1941—Page 34). It presents a message circuit noise weighting applicable to the new telephone set, together with a description of the judgment tests made over a period of four years, from which the weighting was derived. A brief statement is also given of the effect of the new weighting on the established relations between noise magnitude and noise transmission impairment.

Project committee 2J—low frequency influence and susceptiveness, presented a technical report entitled "Positive Disconnection of Distribution Circuits During Faults to Ground." This report gives the results of a study of means for insuring positive disconnection of distribution circuits during faults to ground, particularly from the standpoint of coordination of telephone facilities which are jointly supported on the same poles with the higher voltage distribution circuits. The report includes a brief discussion of important factors involved in providing protection for telephone circuits during contacts with distribution circuits, a consideration of the factors involved in applying ground relaying to distribution circuits, the results of extensive oscillographic observations on the characteristics of distribution circuit ground faults and the performance of distribution circuit protective devices, as well as a number of other matters which have a bearing on the problem of deenergizing distribution circuits under ground-fault conditions.

Project committee 2K — coupling, presented a technical report entitled "Low Frequency Shielding in Telephone Cables." This report replaces those parts of Engineering Report No. 26 which give methods of calculating shielding in telephone cables, and presents methods and material whereby a large variety of shielding problems involving short cables may be solved graphically. In addition, data are presented for types of cables which have come into use since Engineering Report No. 26 was published, among these being coaxial cables, cables with an internal layer shield for carrier transmission, and gopher protected cables. Data are given for new manufacturing schedules of sheath thickness for lead cable and the experimental information on shielding properties of tape-armored cable has been extended. The discussion is limited to cable circuits of length (between repeaters) such that the effects of charging currents associated with conductor capacitance can be neglected.

All of these reports were recommended for engineering report status. Announcement will be made in the BULLETIN when they are approved and available for distribution.

Public Relations Cannot Be Improved by Magic

(*Continued from page* 292)

might prove beneficial in securing ideas and reactions.

(dd) The elimination of an atmosphere of secrecy which oftentimes creeps into a growing organization, especially in matters pertaining to personnel changes and other things affecting groups of employees, should be encouraged if such a condition is noted.

(ee) Greater consideration of employees' convenience in such matters as announcing holidays in advance, considerate regulations about leaving offices for refreshment and relaxation.

(ff) The extension of useful services rendered by Credit Unions.

Summary

The advocacy of the adoption of a definite employee relations program as a forward step to improved public relations is predicated upon the need for creating a more intense degree of human relations between each company and its employees which, in turn, would lead to better relations between the company and the public. It is an often overlooked fact that the very nature of utility employment tends to make the rank and file of jobs of the career type—engineers, construction forces, auditors, in fact, the majority of electric utility workers find it difficult to enter new fields of endeavor due to their training in the peculiarities of utility work. Hence, they view the utility connection as a career and all encouragement should be given them toward making this viewpoint a congenial one.

The program, as suggested, should efficiently and economically create a clear understanding of the company's situation, plans and purposes and enlighten employees on matters pertaining to the private electric utility industry in which the future of their careers lie. Certainly a program of this type would serve as a firm foundation upon which to build a far-reaching and effective means of favorably influencing the public.

PERSONALS

LEONARD A. RICE, who for several years has been general manager for the Arkansas Power and Light Company in Berryville, has been made manager of the Cotter district, to succeed H. B. NUMER, resigned. Mr. Rice will be succeeded by W. A. THOMPSON, formerly supervisor of rural line out of Harrison.

L. A. MORPHY, superintendent of stations of the Northwestern Electric Company, Portland, Ore., has left that organization to join the Pacific Power and Light Company, as assistant superintendent of power. His headquarters are in Kennewick, Wash. He has been with Northwestern for almost 19 years. JOHN HOOPER, who went with Northwestern in 1920, and has for some time been assistant superintendent of stations, succeeds Mr. Morphy.

CHESTER W. JARRETT, who has held various positions with the Portland General Electric Company, has been named manager of the Vancouver, Wash., division of the company. He succeeds LAURIN E. HINMAN, who is on leave of absence to serve as liasion between the national defense commission and industry. RALPH W. JOHNSON, for the past two years manager of the Vancouver, Wash., division of the Portland General Electric Company, has been made assistant division manager of the Williamette Valley division in Salem.

L. M. KLAUBER, formerly vice-president in charge of operation of the San Diego Gas and Electric Company, has been promoted to vice-president and general manager. H. R. PECKHAM, formerly general superintendent, succeeds Mr. Klauber and E. D. SHERWIN advances from assistant general superintendent to general superintendent.

FRED W. BROCKHOFF has assumed new duties as safety engineer of the Union Electric Co., St. Louis, Mo., a new position created by the company to coordinate the accident prevention program throughout the Union Electric System, covering a territory embracing properties in three states, Missouri, Illinois and Iowa.

ARTHUR W. JACKSON, assistant treasurer of Buffalo Niagara and Eastern Power Corp., has been elected treasurer of that corporation to succeed GEORGE J. BRETT, recently moved to New York to take up his duties as controller of Niagara Hudson Power Corp.

LAURENCE W. BUCHANAN, assistant treasurer of Buffalo Niagara Electric, will succeed Mr. Jackson as assistant treasurer of Buffalo Niagara and Eastern Power Corp.

HAROLD R. WALDRON, vice-president of Buffalo Niagara Electric Corp., has been elected vice-president of Buffalo Niagara and Eastern Power Corp.

CONVENTIONS AND MEETINGS

AUGUST

26-29 National Association of Railroad and Utilities Commissioners, St. Paul, Minn.

SEPTEMBER

3-5 Pennsylvania Electric Association, Bedford Springs Hotel, Bedford Springs, Pa.
11-13 Rocky Mountain Electric Association, Stanley Hotel, Estes Park, Colo.
12-13 Wisconsin Utilities Association, Accounting Section, Lawsonia Hotel, Green Lake, Wis.
22-25 Illuminating Engineering Society, Atlanta Biltmore Hotel, Atlanta, Ga.
24-26 Indiana Electric Association, French Lick Springs Hotel, French Lick Springs, Ind.

OCTOBER

6-8 National Electrical Contractors Association, Rice Hotel, Houston, Texas.
6-10 National Safety Council's 1941 Congress and Exposition, Stevens Hotel, Chicago, Ill.
8-10 American Institute of Electrical Engineers, Coronado Hotel, St. Louis, Mo.
12-15 American Society of Mechanical Engineers, Louisville, Ky.
13-14 Wisconsin Utilities Association, Commercial and Technical Sections, Schroeder Hotel, Milwaukee, Wis.
20-24 American Gas Association, Atlantic City, N. J.
27-31 National Electrical Manufacturers Association, Waldorf-Astoria Hotel, New York, N. Y.

DECEMBER

3-5 Congress of American Industry of the National Association of Manufacturers, Waldorf-Astoria Hotel, New York, N. Y.
3-5 American Institute of Electrical Engineers, Southeastern District, New Orleans, La., St. Charles Hotel.

Performance of Distribution Capacitors

(*Continued from page* 298)

to reduce kva loading and improve voltage conditions on distribution systems. Reduction in kilowatt and kilowatt-hour losses and benefits on the transmission system and generating equipment usually have been considered as incidental.

One company reported (in 1937) that on one heavily loaded 4-kv circuit, calculations indicated a 40-kw reduction in kilowatt losses at time of peak load on the circuit.

One company reported that in 1940 an installation of capacitors at the end of a 30-mile transmission line materially reduced the line losses and step-up transformer losses. The installation also improved the voltage regulation and helped through a difficult peak load condition, and reduced the heating on the step-up transformer so that the load could be carried without additional capacity.

Capacitors have interesting possibilities in reduction of kilowatt and kilowatt-hour losses to release generating capacity and reduce fuel costs. Installed near the ends of distribution primaries, they yield the cumulative effects of reduced I^2X and I^2R resulting from the reduced current in each part of the system—including transmission lines, transformers and generating equipment.

Automatic Control of Capacitors

There is an increasing interest in automatic control of capacitors to permit extensive use to raise power factor to close to unity at time of maximum peak loads without leading power factors and high voltages at light loads.

There appears to be a need for lower cost automatic-control switches, especially for small size 3-phase and single-phase banks, to permit installations of capacitors well out on 3-phase and single-phase laterals to obtain the maximum benefits.

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1941-1942

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Georgia Power Co., Atlanta, Ga.

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420 Lexington Avenue, New York, N. Y.

OPERATING COMMITTEE

Chairman, C. W. KELLOGG, New York, N. Y.

E. R. ACKER, Central Hudson Gas & Electric Corp., Poughkeepsie, N. Y.

J. M. BARRY, Alabama Power Co., Birmingham, Ala.

H. C. BLACKWELL, The Cincinnati Gas & Electric Co., Cincinnati, Ohio.

H. B. BRYANS, Philadelphia Electric Co., Philadelphia, Pa.

W. H. BURKE, Ebasco Services Incorporated, New York, N. Y.

C. L. CAMPBELL, The Connecticut Light & Power Co., Hartford, Conn.

J. E. DAVIDSON, Nebraska Power Co., Omaha, Neb.

PAUL M. DOWNING, Pacific Gas and Electric Co., San Francisco, Calif.

E. T. GUSHEE, Union Electric Company of Missouri, St. Louis, Mo.

WILLIAM KELLY, Buffalo Niagara & Eastern Power Corp., Buffalo, N. Y.

FRANK MCLAUGHLIN, Puget Sound Power & Light Co., Seattle, Wash.

W. E. MITCHELL, Georgia Power Co., Atlanta, Ga.

J. F. OWENS, Oklahoma Gas & Electric Co., Oklahoma City, Okla.

W. H. SAMMIS, The Commonwealth & Southern Corp., New York, N. Y.

CHESTER C. SMITH, Kansas City Power & Light Co., Kansas City, Mo.

PHILIP SPORN, American Gas & Electric Service Corp., New York, N. Y.

E. C. STONE, Duquesne Light Co., Pittsburgh, Pa.

E. S. THOMPSON, American Water Works & Electric Co., New York, N. Y.

G. W. VAN DERZEE, Wisconsin Electric Power Co., Milwaukee, Wis.

P. S. YOUNG, Public Service Electric & Gas Co., Newark, N. J.

CHAIRMEN OF THE COMMITTEES

Accident Prevention, GEORGE S. DIEHL, Pennsylvania Water & Power Co., Baltimore, Md.

Accounting Executive, G. H. BOURNE, The Commonwealth & Southern Corp., New York, N. Y.

Classification of Accounts, to be announced.

Customers' Relations, Commercial Accounting and Collections, to be announced.

Depreciation, to be announced.

Plant Accounting and Records, H. B. HARDWICK, The Commonwealth & Southern Corp., New York, N. Y.

Purchasing Stores and Transportation, to be announced.

Electric Equipment, R. W. WILBRAHAM, United Engineers & Constructors, Inc., Philadelphia, Pa.

Hydraulic Power, E. B. STROWGER, Buffalo, Niagara & Eastern Power Corp., Buffalo, N. Y.

Insurance, J. H. NICKELL, Philadelphia Electric Co., Philadelphia, Pa.

Membership, EDWARD REYNOLDS, Columbia Gas & Electric Corp., New York, N. Y.

Prime Movers, J. A. KEETH, Kansas City Power & Light Co., Kansas City, Mo.

Prize Awards, H. P. LIVERSIDGE, Philadelphia Electric Co., Philadelphia, Pa.

Rate Research, F. A. NEWTON, The Commonwealth & Southern Corp., New York, N. Y.

General Sales, R. E. FISHER, Pacific Gas & Electric Co., San Francisco, Cal.

Statistical, W. G. BOURNE, JR., The Commonwealth & Southern Corp., New York, N. Y.

Transmission and Distribution, E. V. SAYLES, The Commonwealth & Southern Corp., Jackson, Mich.

Codes and Standards (a Subcommittee of the Operating Committee)
(To be announced)

BOARD OF TRUSTEES
OF THE
EDISON ELECTRIC INSTITUTE
1941-1942

(Terms expiring 1942)

JAMES B. BLACK.....Pacific Gas and Electric Company, San Francisco, Cal.
JAMES F. FOGARTY.....The North American Company, New York, N. Y.
C. W. KELLOGG.....Edison Electric Institute, New York, N. Y.
B. W. LYNCH.....San Diego Gas & Electric Co., San Diego, Cal.
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THOMAS N. MCCARTER.....Public Service Electric and Gas Company, Newark, N. J.
H. HOBART PORTER.....American Water Works & Electric Company, Inc., New York, N. Y.
HERBERT A. WAGNER.....Consolidated Gas, Electric Light & Power Company of Baltimore, Baltimore, Md.
JUSTIN R. WHITING.....The Commonwealth & Southern Corporation, New York, N. Y.

(Terms expiring 1943)

HARVEY C. COUCH.....Arkansas Power & Light Company, Pine Bluff, Ark.
PHILIP G. GOSSLER.....Columbia Gas & Electric Corporation, New York, N. Y.
H. P. LIVERSIDGE.....Philadelphia Electric Company, Philadelphia, Pa.
WILLIAM MCCLELLAN.....Union Electric Company of Missouri, St. Louis, Mo.
P. L. SMITH.....Middle West Corporation, Chicago, Ill.
GEORGE N. TIDD.....American Gas & Electric Company, New York, N. Y.
JOHN E. ZIMMERMANN.....The United Gas Improvement Company, Philadelphia, Pa.

(Terms expiring 1944)

D. C. BARNES.....Engineers Public Service Company, New York, N. Y.
SAMUEL FERGUSON.....The Hartford Electric Light Company, Hartford, Conn.
P. H. GADSDEN.....The United Gas Improvement Company, Philadelphia, Pa.
C. E. GROESBECK.....Electric Bond and Share Company, New York, N. Y.
W. J. HAGENAH.....Public Utility Engineering & Service Corp., Chicago, Ill.
EDWARD REYNOLDS.....Columbia Gas & Electric Corporation, New York, N. Y.
A. H. SCHOELLKOPF.....Niagara Hudson Power Corporation, New York, N. Y.
E. W. WAKELEE.....Public Service Corporation of New Jersey, Newark, N. J.